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Determinants of Maternal Mortality: A Comparison of Geographic Differences in the Northern and Southern Regions of Cameroon

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Graduate Program in Epidemiology and Biostatistics
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Abstract

The global decline in maternal mortality has not been experienced in Cameroon. Instead, maternal mortality has increased. With a predominantly young population, high maternal death may persist. It is unknown if the North and South, the most distinct parts of Cameroon, differ on levels and determinants of maternal mortality.

This study assessed differences between the North and South of Cameroon on the levels and determinants of maternal mortality using Cameroon Demographic and Health Surveys and multivariable logistic regressions.

Age, parity and education were associated with maternal mortality in Cameroon as a whole. Distance to facility was only significant in the North while domestic violence and ethnicity were associated with maternal mortality in the South.

Regional differences in maternal mortality exist in Cameroon. The findings of this study highlight the need for strategies to improve the socioeconomic and sociocultural conditions of women in the North and South of Cameroon respectively.

Keywords

Maternal mortality, maternal health, maternal mortality in Cameroon

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List of abbreviations

ARV	Antiretroviral
BUCREP	Bureau Central des Recensements et des Études de Population
CDC	Centers for Disease Control and Prevention
CDHS	Cameroon Demographic and Health Surveys
DHS	Demographic and Health Surveys
EA	Enumeration Area
GDP	Gross Domestic Product
GFR	General Fertility Rate
HIPC	Heavily Indebted Poor Countries
ITN	Insecticide Treated Bed Nets
LLIN	Long Lasting Insecticide-treated Nets
LMICs	Low and Middle Income Countries
MDG	Millennium Development Goal
MICS	Multiple Indicator Cluster Surveys
MINSANTE	Ministère de la Santé Publique
MMR	Maternal Mortality Ratio
MMRate	Maternal Mortality Rate
NMCP	National Malaria Control Program
PHC	Primary Health Care
PMTCT	Prevention of Mother to Child Transmission
SAP	Structural Adjustment Program
SDG	Sustainable Development Goal
UN	United Nations
UNICEF	United Nations Children's Fund
UNFPA	United Nations Population Fund
USAID	United States Agency for International Development
WHO	World Health Organization

Chapter 1: Introduction

1 Maternal Mortality

Maternal mortality, which is the death of a woman during pregnancy, delivery, or within 42 days of childbirth, accounts for about 830 deaths everyday worldwide (World Health Organization [WHO], 2016). It mainly occurs in resource limited settings from preventable causes and affects women of childbearing age (15-49 years of age) with poorly met health needs (WHO, 2016b). Maternal mortality is unevenly spread geographically with stark differences between developed and developing countries (Ronsmans & Graham, 2006). Developing nations bear the brunt (99%) of maternal deaths with over 50% occurring in sub-Saharan Africa (Hill et al., 2007; WHO, 2015). It is an indicator for women's status and inequality (Alvarez, Gil, Hernández, & Gil, 2009) and also reflects a country's development in relation to its health care system (Iqbal, Shaheen, & Begum, 2014).

1.1 Impact of maternal mortality

The consequences of maternal mortality go beyond the death of an expectant mother whose moment of joy turns into a tragedy for herself, extending to her child, family and community (Molla, Mitiku, Worku, & Yamin, 2015; Piane, 2009). Maternal death correlates with child and infant mortality particularly in the first year of life (Moucheraud et al., 2015; Rogo, Oucho, & Mwalali, 2006). Surviving children may experience decreased attention in the areas of nutrition, education, and health care. Families afflicted with maternal death might be burdened with raising orphaned children, while the likelihood of child labor (National Research Council, 2000) and the risk of poverty are increased for the family members who accept responsibility for the children of deceased women (Molla et al., 2015). Worthy of note is the impact the death of a pregnant woman has on the attending health caregivers. Some individuals experience depression, self-doubt, and lifelong guilt; some health caregivers may ultimately end their careers (Lawson & Keirse, 2013).

1.2 Measurement of maternal mortality

Accurately quantifying maternal mortality is problematic (Kassebaum et al., 2014) due to underreporting or misclassifications of maternal deaths in vital registries. Low and middle income countries, with unreliable health systems, obtain vital records data from household surveys (Rogo et al., 2006). These surveys remain limited in number, making the existing measurements of maternal mortality, at best, underestimates of the burden. Difficulty in identifying maternal death arises from the need to ascertain a woman's reproductive age, pregnancy status around death, and the cause of death (WHO, 2004b) before a death can be classified in this manner.

1.2.1 Importance of measuring maternal mortality

Still, measuring maternal mortality remains crucial in the assessment of the health status of women in a particular country. The indicators obtained from measuring maternal mortality are useful for planning, implementing and monitoring initiatives to improve maternal health. Also, measures of maternal mortality assess the impact of programs in terms of reductions in maternal deaths, and complications during pregnancy and childbirth. They shed light on progress or constraints on the efforts of individual countries to improve maternal health such as an increase in maternal health services utilization by women or an increase in home births (W. J. Graham, Ahmed, Stanton, Abou-Zahr, & Campbell, 2008).

Measuring maternal mortality at the national level is important. Information provided by national level data offer advantages because of the representativeness of the population and breadth of information that these data contain. National level data can be achieved through assessing facility health data in a country. Rwanda is one country that measured maternal deaths at the national level by using data from a nationwide cohort of health facilities (Sayinzoga et al., 2016).

However, facility based data have historically been prone to incomplete reports (W. J. Graham & Campbell, 1992), because they do not contain data for women who die of maternal related causes outside of the health care system (Hoj, da Silva, Hedegaard, Sandstrom, & Aaby, 2002). National household surveys capture these maternal deaths that occur within communities. Measuring maternal mortality at the national level enables individual countries to establish the magnitude and trends of the problem within their own populations.

1.3 Factors associated with maternal mortality in developing countries

Several factors, at the individual and community level, are linked directly or indirectly with maternal mortality (Alvarez et al., 2009; Rogo et al., 2006). Direct factors comprise pregnancy (a precondition for maternal mortality) and complications such as hemorrhage, eclampsia, sepsis, abortions, and obstructed labor (Alvarez et al., 2009; McCarthy & Maine, 1992). Indirect factors are involved in situations where a woman's pre-existing conditions such as malaria, anemia and nutrition are aggravated by pregnancy, which in turn may impact a pregnancy outcome (Alvarez et al., 2009). Also, women's reproductive status, in light of elements such as age and parity, are associated with maternal death. Access to health services, women's health seeking behavior and use of health services can indirectly affect the outcome of maternal death. Socioeconomic, environmental, and cultural factors impact maternal mortality (Illah et al., 2013; McCarthy & Maine, 1992).

These factors, can also lead to short or long term disabilities (fistula, pelvic inflammatory disease, and ruptured uterus) which may severely affect the lives of women and their subsequent pregnancy outcomes (Wall, 1998). For every woman who dies from maternal related factors, about 20 to 30 women are said to endure maternal morbidity (WHO, 2010). The latter tend to have unmet health needs due to their lack of awareness about available treatments. This increases their risk of maternal death from subsequent pregnancies.

1.4 Geographic variation of maternal mortality in developing countries

Variations in maternal mortality (levels and determinants) exist between and within countries (WHO, 2016b). High maternal mortality levels and variations in its determinants in Low and Middle Income Countries (LMICs) like those in Sub-Saharan Africa, challenge maternal health programs.

The impact of any determinant of maternal mortality depends on the specific region. For example, maternal age, played a role in Matlab Bangladesh (Chowdhury et al., 2007), but not in Guinea-Bissau (Hoj et al., 2002) where lack of care and inadequate health services were the strongest predictors of maternal death.

Within Nigeria, there is a wide variation in the levels of maternal mortality. The South West and North East regions had maternal mortality ratios of 166 maternal deaths and 1,549 maternal deaths per 100,000 live births respectively in 1999 (Lanre-Abass, 2008). Significant regional differences were seen in the use of government facilities for childbirth in Nigeria (Aremu, Lawoko, & Dalal, 2011). Similarly, urban and rural differences in maternal mortality exist within many developing countries (WHO, 2016b). Urban areas of Iran had higher maternal deaths compared to rural areas (Poorolajal, Alafchi, Najafi Vosoogh, Hamzeh, & Ghahramani, 2014).

These differences in the determinants of maternal mortality between and within countries have implications for country specific programs implemented to reduce maternal deaths. It is possible that Cameroon, the country of interest for this study, may have similar geographic differences in the levels and determinants of maternal mortality.

1.5 Cameroon and maternal mortality

Cameroon is very diverse with over 200 tribes grouped as Highlanders (31%), Equatorial Bantu (19%), Kirdi (11%), Fulani (10%), North Western Bantu (8%) Eastern Nigritic (7%) and others (14%) (Central Intelligence Agency, 2016). These smaller groups make up the 3 main ethnic groups of Bantus, semi-Bantus and Sudanese (Republic of Cameroon, 2016). The country is broadly bisected about the center by the Adamawa Plateau; north of which are predominantly the Fulani and Kirdi people, and to the south are largely the Highlanders and Bantu people. Also, the two areas are the most diverse parts of Cameroon varying in climate, geography, culture and religion.

Cameroon, like many other sub-Saharan African countries, has a high burden of maternal mortality. The global decline (by 44%) in maternal mortality has not been seen in Cameroon. Instead, Cameroon has seen a rise in maternal deaths with 782 maternal deaths /100,000 live births occurring in 2011 (Institut National de la Statistique & ICF International, 2012; République du Cameroun MINSANTE, 2015). Previously, rates were 669 /100,000 and 454/100,000 live births in 2004 and 1998 respectively (Barrère, 2004; Institut National de la Statistique & ORC Macro, 2004b). Cameroon still has a high fertility rate of 5.1 children per woman and a third of women having their first child before age 18 years (République du

Cameroun MINSANTE, 2015). With a predominantly young population (about 60% of whom are under 25 years), the high maternal death rates in Cameroon may persist or steadily increase.

Geographic disparities influence maternal mortality. Evidence of within country variation seen in other LMICs underlie the need to assess the factors that explain differences in maternal mortality in different regions. These differences may exist in Cameroon, particularly between the Northern and Southern regions of Cameroon. Yet, it is not known if the North and South, the most distinct parts of Cameroon, differ on maternal mortality. Specifically, the levels (rates and ratios) and determinants of maternal mortality in the North and South and whether they differ are unknown.

1.6 Importance of study

Reducing maternal mortality is imperative. Cameroon is among the countries with the highest maternal mortality level at 782 maternal deaths per 100,000 live births in 2011 (République du Cameroun MINSANTE, 2015) in sub-Saharan Africa, representing an enormous burden for the country and its people. To date, no known study has explored the geographic differences in maternal mortality within Cameroon using national level data to identify factors associated with mortality within the country. This study estimated the levels of maternal mortality and assessed differences in its determinants between the North and South of Cameroon. Findings from this study may provide new knowledge about maternal mortality in Cameroon and guide interventions and prevention strategies with implications for national and regional policies.

1.7 Thesis structure

This thesis is organized in five main chapters. Chapter one introduces the study and provides an overview of the background on maternal mortality at the global level and in Cameroon. This is followed by sections on factors associated with maternal mortality, geographic variations of maternal mortality in developing countries and the importance of the study. Chapter two introduces and defines concepts related to this study. It also provides a review of determinants of maternal mortality in developing countries and describes the background characteristics of Cameroon. Chapter two closes with the study objectives, research questions, and the study significance. Chapter three deals with the methods employed to achieve the objectives of this thesis. It introduces the conceptual framework of analyzing maternal mortality, the data source and data management. It provides details on how the variables selected for this study were

operationalized and how data was analyzed. Chapter four presents the results of the study according to the research questions with tables to demonstrate complete findings. This thesis closes with chapter five which presents a summary and interpretations of the findings from chapter four. Chapter five concludes with the study limitations, strengths, and recommendations.

Chapter 2: Literature review

This chapter describes maternal mortality, and its determinants in developing countries.

Background information on Cameroon, the two distinct regions of the North and South of the country, is presented. The impact of maternal mortality in Cameroon is also reviewed in detail followed by the study rationale and study objectives.

2 Maternal mortality

According to the International Classification of Diseases (ICD-10), maternal mortality is the “death of a woman while pregnant, or within 42 days of delivery or termination of pregnancy from any cause related to or aggravated by pregnancy and its management but not from accidental or incidental causes” (Filippi, Chou, Ronsmans, Graham, & Say, 2016; WHO, 2014b). About 50% to 71% of maternal deaths occur in the postpartum period and between 11% and 17% during childbirth (Alvarez et al., 2009; Li, Fortney, Kotelchuck, & Glover, 1996).

The year 2000 marked the declaration of eight Millennium Development Goals (MDGs) by the United Nations (UN) which brought a new international focus on maternal health through MDG 5. This called for the reduction of maternal mortality by 75% between 1990 and 2015 and for universal access to reproductive health for the improvement of maternal health (Filippi et al., 2016; Ronsmans & Graham, 2006). Globally, efforts towards achieving MDG 5 have been met with progress towards the reduction of maternal mortality; evidenced by a decline of about 44% in maternal deaths (WHO, 2016b).

In 2000 and prior, there were over half a million maternal deaths globally (Abou-Zahr & Royston, 1991; Ronsmans & Graham, 2006) which dropped to about a quarter million by 2015 (WHO, 2016b) signifying that maternal deaths could indeed be reduced globally with the right approach. In this light, maternal mortality has gained renewed focus with the Sustainable Development Goal (SDG) 3 which seeks to further reduce maternal deaths to less than 70 per 100,000 live births (WHO, 2016b) by 2030 (United Nations, 2015). Still, maternal mortality remains a major burden for developing countries, particularly in Sub-Saharan Africa and South Asia, where 99% of all maternal deaths occur (WHO, 2016b). Sub-Saharan Africa bears over half the burden and lags on progress towards reducing maternal mortality (Filippi et al., 2016; Ronsmans & Graham, 2006).

2.1 Causes of maternal mortality in developing countries

Maternal mortality claims the lives of many women in developing countries, often from factors that could have been prevented, in resource limited and fragile settings (WHO, 2016b). The leading causes of these death are either direct or indirect (Rogo et al., 2006).

2.1.1 Direct causes

A direct cause of maternal death is any disease or complication that occurs only during pregnancy like labor and puerperium, and from interventions, omissions, or incorrect treatment that lead to death (Rogo et al., 2006). Direct causes of maternal mortality include factors such as severe bleeding, high blood pressure, complications after delivery, infections and unsafe abortions (Abou-Zahr & Royston, 1991; Filippi et al., 2016; WHO, 2016b). In Africa, hemorrhage, sepsis and hypertensive disorder were the leading causes of maternal death (Khan, Wojdyla, Say, Gülmezoglu, & Van Look, 2006).

2.1.2 Indirect causes

An indirect cause of maternal mortality is any preexisting condition prior to pregnancy or that develops during pregnancy and is aggravated by pregnancy leading to death (Abou-Zahr & Royston, 1991) These include health states such as anemia which increases the risk of complications in pregnant women (Ronsmans & Graham, 2006) and preexisting infectious diseases such HIV/AIDS, which is the major indirect cause of maternal death in Sub-Saharan Africa (Filippi et al., 2016).

Direct and indirect causes of maternal mortality are not easily distinguished. Maternal mortality is often a multifactorial outcome that makes the task of categorizing its cause difficult. Anemia is one factor that has been classified as both a direct and indirect cause of maternal death (Brabin, Hakimi, & Pelletier, 2001). This is because anemia can cause maternal death or worsen other causal factors like hemorrhage at childbirth (Rogo et al., 2006). With multiple contributing factors, it is not always easy to detect the factor that directly or indirectly caused maternal death.

2.2 Measuring maternal mortality

As a global priority, there is still considerable need for improved knowledge about maternal mortality especially in regions like Sub-Saharan Africa where maternal deaths are highest and vital registration is inadequate. Maternal mortality is the outcome for assessing achievements on MDG 5. Some of the common measures of maternal mortality are maternal mortality ratio, maternal mortality rate, lifetime risk of maternal death, and proportionate mortality ratio measured in women of reproductive age (Ronsmans & Graham, 2006).

a) **Maternal mortality ratio**

Maternal mortality ratio is defined as the number of maternal deaths during a specific time period per 100,000 livebirths during the same time period (Ronsmans & Graham, 2006). By expressing maternal death in terms of livebirths, maternal mortality ratio measures risks of death due to obstetric causes (Ahmed, Li, Scrafford, & Pullum, 2014). It represents the risk of maternal mortality with each pregnancy and is an essential indicator for developing countries, where complications arising during pregnancy and delivery are the leading cause of death.

b) **Maternal mortality rate**

Maternal mortality rate is the number of maternal deaths in a given period per 1000 women of reproductive age. This is a measure for the risk of maternal death to women of reproductive age from a given pregnancy (Ahmed et al., 2014; Ronsmans & Graham, 2006). It provides the magnitude of the burden of maternal deaths among women. (Abou-Zahr & Royston, 1991).

c) **Lifetime risk of maternal death**

This is the probability of maternal death during the 35 years of a woman's reproductive life for a woman who survives to age 15 years (Ahmed et al., 2014; Ronsmans & Graham, 2006).

d) **Proportionate mortality ratio**

This measures maternal death as a proportion of all female deaths of women of reproductive age (Ronsmans & Graham, 2006)

Among all these measures, maternal mortality ratio and maternal mortality rate (MMRate) are frequently used. Maternal mortality ratio (MMR) is the most commonly used measure of maternal deaths and is the chosen MDG 5 indicator (WHO, 2014b). It is the preferred measure because it captures the burden of maternal mortality due to obstetric causes which are the leading causes of maternal death in developing countries. Maternal mortality rate (MMRate) on the other hand captures the fertility level in the population (WHO, 2014a).

2.3 Data source and methods of measuring maternal mortality

Maternal mortality is measured with data from sources like vital registration and health service records (WHO, 2016b). Vital registrations are often not readily available for countries with the highest burden of maternal mortality. In the absence of reliable records to accurately measure maternal mortality, data can be obtained through large population based surveys, national census, facility-based studies and statistical model estimates (WHO, 2014b).

Information on maternal mortality in developing countries are widely obtained using household surveys. These involve the collection of information about sibling survivorship from respondents. The sisterhood method (indirect and direct) and verbal autopsy technique are some approaches that can be included in household surveys to obtain data on maternal death (WHO, 2014a). These are described below.

2.3.1 Indirect sisterhood method

The indirect sisterhood approach is the original sisterhood method of measuring maternal mortality. It includes four questions that are asked of respondents about their sisters. Specifically, they ask about sisters that reached adulthood, how many are alive, how many have died, and whether those who died were pregnant at the time of death (WHO & UNICEF, 1997). These data provide a summary sibling history used to estimate maternal mortality (W. Graham, Brass, & Snow, 1989; Merdad, Hill, & Graham, 2013). This method collects less information than the direct method about sibling's death over a long period of time (usually 12 or more years). This method requires a smaller sample of respondents because respondents in populations with high fertility tend to report multiple sisters (Merdad et al., 2013). Data from indirect methods enable the estimation of lifetime risk of maternal mortality.

2.3.2 Direct sisterhood method

The direct sisterhood method is a variant of the indirect sisterhood method. It expands on the latter by including more in-depth questions about deceased siblings such as age at death, year of death, and timing of death (during pregnancy, childbirth or within 2 months of delivery) (WHO & UNICEF, 1997). This method collects information from respondents that constitutes a full sibling history (W. Graham et al., 1989) and provides more details for estimating maternal mortality (The DHS Program, n.d.-a). It is preferred for population surveys because it enables the calculation of rates/ratios of maternal mortality for specific periods in time, and allows for trends to be monitored.

2.3.3 Verbal autopsy

Other sources for maternal mortality estimates are verbal autopsies for maternal death. Verbal autopsy is a technique used to determine maternal death in places where a substantial proportion of deaths occur at home or in the absence of health personnel. The technique involves in-depth interviews with relatives of the deceased about the signs and symptoms, and the circumstances surrounding death in order to assign the most likely cause of death (WHO, 1994b, 2004a). These sources provide useful data that are used to derive measures of maternal mortality.

2.4 Challenges and limitations of measuring maternal mortality

Maternal mortality is difficult to quantify and its measures are susceptible to inaccuracy. This is due to poor and unreliable data (Filippi et al., 2016; Kassebaum et al., 2014; Rogo et al., 2006; Ronsmans & Graham, 2006). Many national health programs in developing countries are unable to measure and account for factors that influence maternal health in part because of inadequate vital registration and health systems, as well as the underuse of available information. Existing systems for recording maternal deaths tend to be weak. Maternal deaths are often underreported as family members may prefer not to disclose maternal death of siblings. Deaths may be misclassified in vital registries as nonmaternal. This has led to reliance on other sources of data like population-based data from national surveys for measuring maternal mortality.

Maternal death is a rare event which requires large sample sizes for measurement. This calls for national level data that is usually collected from household surveys. Though these produce a

wealth of data to estimate maternal mortality ratios, they are often expensive and challenging to implement (Rogo et al., 2006).

Many developing countries like Cameroon rely on Demographic and Health Surveys (periodic national population surveys) to collection information on maternal deaths. These surveys use the direct sisterhood method which is deemed more informative with fewer assumptions compared to the indirect sisterhood method (WHO, 2004b).

2.5 Determinants of maternal mortality in developing countries

2.5.1 Reproductive status:

Age

Age is a strong factor in the death or survival of a pregnant woman (Abou-Zahr & Royston, 1991; Diorio & Crivelli-Kovach, 2014; Mbassi, Mbu, & Bouvier-Colle, 2011; McCarthy & Maine, 1992; Wall, 1998). Risk of maternal death varies with woman's age. Though the risk of death increases with age (Hoyert, Danel, & Tully, 2000), very young women, and those closer to the end of their childbearing years, have the highest risk (Hoj et al., 2002; McCarthy & Maine, 1992). Specifically, pregnancy related deaths are highest among girls age 15 years and younger and also among women older than 30 years (Wall, 1998). Young women may face this dire outcome because they are still developing or growing and are not mature enough to bear children (Abou-Zahr & Royston, 1991).

A global analysis of maternal mortality in 188 countries reported that risk was highest in the oldest group of women of childbearing age (Kassebaum et al., 2014); however, women in developing countries like Cameroon, start childbearing at an earlier age compared to women of the developed world (Amzat, 2015). This is fostered by the legal recognition of marriage involving a girl as young as 15 years of age which encourages the start of childbearing at an early age. Adolescent pregnancies are prevalent in Cameroon. About 12% of all deliveries in the capital city of Cameroon (Yaoundé) were teenage deliveries of girls 16 years and younger (Kongnyuy et al., 2008). Complications from pregnancies in tertiary level facilities in Cameroon occur mostly among patients younger than 20 years and older than 31 years of age (Mbassi et al., 2011).

Parity

Like age, parity affects the outcome of a pregnancy (Abou-Zahr & Royston, 1991; Buor & Bream, 2004; Mbassi et al., 2011; McCarthy & Maine, 1992) and together, age and parity are the most important risk factors of maternal death (Hoj et al., 2002). The total number of pregnancies is correlated with maternal death (Wall, 1998). Risk of maternal death is high for nulliparous and grand multiparous women (McCarthy & Maine, 1992). This is because of obstetric complications like postpartum hemorrhage in first pregnancies and in women with five or more past births. Second and third pregnancies are usually the most trouble free, with increasing risks in subsequent pregnancies (Abou-Zahr & Royston, 1991). Repeated pregnancies exert a burden on a woman's health (Defo, 1997) which increases the risk of uterine rupture. Likewise, multiple pregnancies increase the risk of maternal death (Hoj et al., 2002).

The influence of parity on maternal mortality is a concern for women in Africa where the fertility level is high (Amzat, 2015; Buor & Bream, 2004). High parity, specifically in Cameroon, remains a major issue; however, how parity in Cameroon relates to maternal mortality needs to be explored. Limited reach of family planning, the pressure for large families, the fear of childlessness and the fear of husbands taking on new wives serve to promote this issue (Weinger & Akuri, 2007). There is a penchant for large family sizes in Africa, for which a woman may not necessarily have a say in the decision (Amzat, 2015). This makes women bear many children often with poor spacing pre-disposing them to pregnancy related complications (Amzat, 2015).

2.5.2 Access to health services:

Distance to facilities

The risk of maternal mortality rises with increasing distance to health facility (Hoj et al., 2002). Physical distance to health facilities can impact maternal health since this serves as a barrier to accessing health care for women and for mothers in particular. (Chimfutumba, Anchang, Ongore, & Nyabola, 2015; McCarthy & Maine, 1992). Long distances to health facilities remain a problem in Africa (Amzat, 2015). In Guinea Bissau, women living farther from the hospital were found to have an increased risk of maternal death compared to those living closer to the hospital (Hoj et al., 2002). Long distances from health facility may entail costly transportation, and tedious journeys (Hoj et al., 2002) often aggravated by a lack of transportation (Abou-Zahr &

Royston, 1991). This forces women to walk and choose facilities based on proximity, leading to delays in seeking help or preventing women from seeking help at all (Amzat, 2015). In Tanzania, physical distance to facility was the most cited reason for home delivery (Choe et al., 2016). Maternal mortality was associated with time (greater than one hour) to get to health facility in Mezam division of the North-West region of Cameroon (Egbe et al., 2016). However, the extent of the influence of distance to facilities on maternal mortality in Cameroon in the broader northern and southern regions is not known.

Media exposure

Media are effective tools for informing and educating the public about health issues and raising awareness about new evidence-based interventions to improve healthcare. These media have traditionally been television, radio and print media. Recent times have seen the use of internet and mobile phones to communicate information which can affect health behavior (Wakefield, Loken, & Hornik, 2010). In Cameroon, the media are heavily controlled by the government which levies heavy sanctions against media corporations and citizens for sharing information deemed controversial or portraying an unflattering image of the government. This has lessened media credibility, particularly state-run media in the country, and raises the question of the impact media exposure may have on maternal mortality in Cameroon. Poor distribution of print media limits its impact outside the major cities of Cameroon (U.S Department of State, 2007). This is further hampered by government taxes that increase the price of print media.

Radio and television, however, remain vital for reaching the masses as typical health campaigns have used these options to influence large numbers of people through repeated, low cost drives (Wakefield et al., 2010). Media campaigns are useful in changing health behavior. They were instrumental in influencing health behavior on issues such as tobacco, alcohol, and physical activity (Wakefield et al., 2010). Birthrate reduction and HIV infection prevention in Sub-Saharan Africa are gains attributed in part to media campaigns (Jung, Arya, Viswanath, Viswanath, & Zimmerman, 2013; Wakefield et al., 2010). There is a need to assess the impact of media on maternal mortality in Cameroon, where it is used to educate women on maternal health care information and services. In Tanzania, media exposure was associated with an increase in facility births in urban areas (Choe et al., 2016). In Nigeria, media exposure was also positively associated with utilization of antenatal care (Rai, Singh, & Singh, 2012). Adolescent mothers,

women in rural settings and those of low educational status, who had low media exposure, were less likely to use antenatal care services in Nigeria.

2.5.3 Healthcare seeking behavior

Type of contraception used – family planning

Through the World Fertility Survey Program, developing countries were able to obtain improved data on fertility, which led to the adoption of family planning as a strategy for improving maternal health (to cut the number of unwanted pregnancies and reduce maternal deaths), (AbouZahr, 2003; Sprehe, 1974). Family planning (such as use of contraceptives), reduces poverty, hunger, and empowers women by reducing family size (Nansseu, Nchinda, Katte, Nchagnouot, & Nguetsa, 2015). An increase in contraceptive prevalence is also associated with a reduction in maternal mortality (Alvarez et al., 2009). Falling maternal mortality in Matlab, Bangladesh was associated with family planning initiatives (Chowdhury et al., 2007) while in African countries like Cameroon, with the lowest use of family planning in the world (Chimfutumba et al., 2015), high fertility rates persist (Buor & Bream, 2004). Cameroon's prevalence of modern contraception has remained under 20% (UN Economic & Social Affairs, 2015).

Low use of modern contraception is due primarily to lack of access with about 30% of women in sub-Saharan Africa having an unmet need for modern family planning methods (Chimfutumba et al., 2015). The use of contraceptives is also low in young wives (Diorio & Crivelli-Kovach, 2014). This group is reported to equally suffer from other unmet health needs and high fertility. A study in the Santa health district (in the South of Cameroon) revealed side effects of contraception and husband's disapproval to be some of the major deterrents to their use (Chimfutumba et al., 2015). This results in the pervasive use of illicit abortion services in Cameroon where abortion is illegal (Chimfutumba et al., 2015) except for specific cases where a woman's life is in imminent danger. Low use of contraceptives may be related to maternal mortality in Cameroon.

2.5.4 Health status

Nutrition

Nutritional status influences maternal health outcomes (McCarthy & Maine, 1992). Malnutrition is a major cause of iron deficiency anemia, which increases the risk of maternal mortality. This is because anemic women have less tolerance of blood loss and so have a higher risk of death in the event of hemorrhage at delivery (Abou-Zahr & Royston, 1991). The prevalence of iron deficiency anemia is high in developing countries, (Rush, 2000) and many women in Africa are nutritionally deficient when they become pregnant (Rogo et al., 2006). In Cameroon, malnutrition persists in regions like the North in part because of cultural practices that influence diet (Defo, 1997). Prolonged malnutrition exacerbates the impact of other health conditions like malaria on a pregnancy outcome.

2.5.5 Women's characteristics

Social autonomy

Maternal health is a basic human right and maternal mortality is high in communities with low women's social status (Abou-Zahr & Royston, 1991). Lack of autonomy/decision making among women is strongly correlated with pregnancy outcomes and maternal survival (Rogo et al., 2006). Amzat (2015) argued that, while women's rights are affected at the political level, they are also affected at the household and community level where lack of autonomy limits social status. This is seen in women's lack of control on their reproductive health, inequalities in decision making, domestic confinements and no participation in their health care, in cases where partners and husbands unilaterally make decisions (Amzat, 2015).

Lack of autonomy translates into a woman having minimal control on her own affairs in health care. This problem is widespread in many cultures in Africa where women are subject to patriarchal dominance, requiring permission to exercise any activity (Amzat, 2015). Lack of autonomy plays an important role in maternal health outcomes, predisposing women to frequent births when male children are preferred over female, and at risk of complications due to frequent and poorly spaced pregnancies (Amzat, 2015). Autonomy was low in women across different socioeconomic status in Burkina Faso (Pambè, Gnoumou, & Kabore, 2014). Traditional gender

roles where women are underpowered and subject to the authority of men influence autonomy. Lack of awareness, together with low autonomy, promote high incidence of HIV in women (Weinger & Akuri, 2007). This influences maternal health and may reflect women's autonomy in Cameroon where HIV prevalence is highest in women, particularly those from wealthy households (Hajizadeh, Sia, Heymann, & Nandi, 2014).

Domestic violence

Domestic violence, physical, sexual or emotional, is a global problem that affects women's wellbeing. For women, homicide (Stöckl et al., 2013), depression, suicidal behavior (Devries, Mak, Bacchus, et al., 2013), HIV infection (Jewkes, Dunkle, Nduna, & Shai, 2010) and induced abortions are outcomes linked with intimate partner violence. Domestic violence influences the use of contraceptives by either increasing or decreasing use depending on the location (country/region) and other unique circumstances of the woman (Kidman, Palermo, & Bertrand, 2015). For instance, in Uganda, most women who experience violence tend to have experienced more than one form of violence, and find domestic violence acceptable (Kouyoumdjian et al., 2013). The perception that a man is justified in perpetrating violence towards his wife or partner under the guise of discipline is widely acceptable in Wakiso district, Uganda, where domestic violence is reported to be common even during pregnancy (Kaye, Mirembe, Ekstrom, Bantebya, & Johansson, 2005). In Cameroon, women who had experienced intimate partner violence were at an increased risk for induced abortion (Alio et al., 2011).

Africa bears a large burden of the world's domestic violence and the related negative health consequences (UN Economic Commission for Africa, 2010). Still, limited comparative data on the specific measure of exposure to violence in population studies, challenge the international community's effort to guide policy development and monitor progress on domestic violence prevention (Devries, Mak, García-Moreno, et al., 2013). Such information will enable the recommendation of effective policies and culturally appropriate strategies to curb domestic violence. Factors that could lead to improved women's status (such as education and wealth), are shown to also predispose women to domestic violence (Pambè et al., 2014). Empowerment can mean a woman being able to challenge her partner's decision or action, providing an avenue for conflict between woman and her partner (Kaye et al., 2005). This shows an inconsistent

mechanism through which empowerment factors affect domestic violence. Ultimately, domestic violence is present in all strata of women, women of low and high socioeconomic status, in rural and urban settings, and pregnant and non-pregnant women (Kaye et al., 2005).

Education

Education is inversely related with the risk of maternal mortality (Abou-Zahr & Royston, 1991; Alvarez et al., 2009; Buor & Bream, 2004; Defo, 1997; Mbassi et al., 2011; Wall, 1998) with lower educational levels associated with greater risk of maternal death. The bulk of maternal deaths happen in women with primary or no education (Hoj et al., 2002; Hoyert et al., 2000), while higher education reduces the risk of maternal mortality (Chowdhury et al., 2007). This trend is evident in both developed and developing countries. According to Wall (1998), education significantly influenced the difference in maternal mortality between Muslim and Christian Hausa women, where Christians had a higher likelihood of school attendance than Muslims in Northern Nigeria. Compared to men, educational levels are consistently lower in women in developing countries. This is common in Africa where female children are removed from school in favor of marriage (Amzat, 2015; Diorio & Crivelli-Kovach, 2014).

One consequence of low education is that fewer women are able to identify warning signs that may present during pregnancy (Amzat, 2015). Literacy, another way education is assessed, is positively associated with use of antenatal and other health services (Buor & Bream, 2004; Thaddeus & Maine, 1994). In Dabat, Ethiopia, the use of skilled birth attendants was associated with secondary or higher education (Mengesha, Biks, Ayele, Tessema, & Koye, 2013). Education empowers women with the ability to contribute in matters of their fertility, family planning and marital life (Abou-Zahr & Royston, 1991).

Religion

Religious beliefs affect women's health behavior and choices that influence their maternal health outcomes. Religion significantly affects maternal health in Somalia, Mali, Northern Nigeria and Chad where it restricts women's autonomy and rights (Amzat, 2015). These countries share common ethnic and cultural values that are shaped by religious beliefs. In Burkina Faso, Catholic and Protestant women were found to be more likely to partake in decision making about their

healthcare than women of other faiths (Pambè et al., 2014). In Nigeria, religion influences women's choice of health provider and type of delivery. Some women have reportedly refused necessary caesarian sections because their religious leaders advised against them (Ugwu et al., 2015). Similarly, religion affects the attitudes of women in Cameroon (Defo, 1997). Major religious groups promote marriage as the only acceptable condition for procreation. For instance, Muslims in Cameroon shun childbirth out of wedlock with a strong preference for marital childbearing (Defo, 1997). Though this preference is common in other religious groups, its impacts (early marriages and early childbearing in young women), are most visible in Muslim women.

Though religious health facilities help support the delivery of care to women in areas without public health facilities, some of their tenets prevent the use and provision of certain health services. In Cameroon, religious reasons were found to prevent the use of family planning by women in the Santa health district. Religious leaders were cited as the influential figures who disapproved of the use of contraceptives (Chimfutumba et al., 2015). Furthermore, in some Catholic health facilities, counsellors offered counselling about all methods of contraception but refrained from offering any modern method, referring clients, who preferred to use contraceptives, to other facilities that may have attended to their needs (Chimfutumba et al., 2015).

2.5.6 Family status

Ethnicity

Ethnicity influences maternal mortality. Maternal deaths have also been found to be significantly higher in minority ethnic groups. In the US, Blacks have a consistently higher rate of maternal mortality compared to Whites or Hispanics (Hoyert et al., 2000). In the UK, Indian women had a higher association with maternal death compared to other ethnic groups such as Black Africans and Black Caribbeans (Nair et al., 2015). Also, particular ethnic groups (Lobi/Dagara and Gourounsi) in Burkina Faso were found to have more decision making power compared to other groups (Pambè et al., 2014). Others (Marka and Mossi ethnic groups) were found to have a positive association with delivery at health facility (De Allegri et al., 2011). These are factors that influence the outcome of maternal mortality.

Cameroon's ethnic diversity provides a rich cultural environment with strong attachments to traditional beliefs, norms and practices that can influence maternal health outcomes (Defo, 1997). There are cultural practices that can affect maternal health outcomes. These include postpartum abstinence period taboos, and seclusion of unmarried females from unmarried, unrelated males which may prevent unwanted pregnancies. Others include a long breastfeeding period, used to help mothers to space births. On the other hand, Levirate marriages (marriage between a widow and deceased husband's brother), which have been in decline, persist in some ethnic groups and may increase a woman's risk of maternal mortality through grand multiparity. Pride from having large families and having male children in Cameroon foster practices such as arranged marriages and early marriages to ensure a young girl can procreate (Defo, 1997). Variations in Cameroon's ethnic groups may influence maternal mortality particularly in the North and South, where there are differences in the depth of cultural practices (Pemunta & Fubah, 2015).

Type of residence - Rural and urban

Many countries have poorer maternal outcomes in rural than urban areas where health outcomes are better because of easier access to medical services (Abou-Zahr & Royston, 1991). Rural areas in Africa, compared to urban ones, have higher risks of maternal mortality (Wall, 1998). The concentration of medical facilities in urban centers makes it challenging for rural residents to access health services. This is typical of the Cameroonian environment, where medical facilities and health personnel are concentrated in the southern half of the country, particularly in Yaoundé and Douala (Tandi et al., 2015). Similarly, there are differences in health behavior between rural and urban residents. In Nigeria, such differences (urban vs. rural) were seen in maternal healthcare utilization in the adolescent population (Rai et al., 2012). Adolescents in rural settings were less likely to use maternal health services compared to those in urban settings.

The usually few health facilities available in rural residential areas, are accessible with some degree of difficulty (Thaddeus & Maine, 1994). Hoj et al. (2002) assert that lack of money and transportation problems are some difficulties that rural dwellers have in accessing these health facilities. Difficulty in accessing health care services in rural settings may lead to declining health notably due to transportation problems. In fact, individuals have died on the way to

hospitals often because of poor, inadequate or unavailable transportation (Thaddeus & Maine, 1994). Also prone to shortage of both human and material resources, rural health facilities in many African countries become an encumbrance to the provision of care to residents. The distribution of insufficient medical resources first to urban areas only serve to ensure that rural areas are poorly served (van Rensburg, 2014).

Wealth index

Wealth determines economic status and influences outcomes of maternal health. Economic status, which is often assessed through individual assets in developing countries, is closely tied to a woman's birth outcomes, with poorer and marginalized women having a higher risk of death (United Nations Population Fund, 2012). This risk is great for Africa where poverty is pervasive and women tend to be poorer than men (Amzat, 2015). Most maternal deaths occur in relatively poor countries as compared to developed countries. In these poor countries, the poor are most adversely affected (Matthews, 2002). Morbidity and mortality are found to be higher among the poor and also in poor communities (Thaddeus & Maine, 1994).

Matthews (2002), links wealth to health seeking behavior. In communities with improved awareness about the availability of services, economic factors such as financial barriers are particularly pertinent as they negatively affect maternal health (Diorio & Crivelli-Kovach, 2014; Mumtaz et al., 2014). Lack of money or insufficient funds pose a barrier to access to health care (McCarthy & Maine, 1992) as fees and cost of services limit demand and use of these services (Abou-Zahr & Royston, 1991). This is worse for women living in places where the cost of care is borne primarily by the individual (Amzat, 2015). The cost of healthcare is paid for by individuals in Cameroon (Institut pour la Recherche de développement et la Communication, 2012), where poverty affects women in both rural and urban centers (Mbassi et al., 2011). Women in Cameroon indicated that lack of money prevents them from maintaining good health (Weinger & Akuri, 2007), which may adversely affect maternal health outcomes.

2.5.7 Resources

Sanitation: water quality

Poor water quality is a risk factor for maternal mortality; the proportion of people with access to clean water provides insight into the health status of a population (Alvarez et al., 2009). Alvarez et al., (2009) found a strong inverse relationship between maternal mortality and access to improved water source in sub-Saharan Africa. Ordinarily, water should pose no risk of harm to any individual but good quality water, a basic human right, is not available to all. Poor water quality is rampant in many developing countries with poorly maintained sanitation facilities. Cameroon, for instance, is enriched with abundant freshwater resources but adequate supply of good quality water is severely incapacitated by chronic mismanagement. With a growing population, many communities are underserved because the national water management has not been able to increase the network of improved water (Katte, Fonteh, & Guemuh, 2004). The task of assuring access to water for the public is made harder by increasing demands for water from a growing economy in the sectors of agriculture and industry, depletion of water sources by pollution, deforestation and minimal improvements in the already weakened system of water distribution (Katte et al., 2004).

WHO estimates about 80% of all diseases are linked directly or indirectly with poor water quality (Ndjama et al., 2008). In Cameroon, water related diseases account for about 50% of all deaths (Katte et al., 2004). The accelerated population growth in urban centers like Douala, has led to an increase in contaminated water by waste from poorly built homes; this increases the occurrence of infectious diseases (Ndjama et al., 2008). This situation essentially assures the endemic nature of some infectious diseases in the country. Similarly, Katte et al. (2004), found an unacceptable increase in bacterial load in the water table of the city of Dschang (South Cameroon) because of leaks from septic tanks. Challenges with access to improved water force some women to fetch water away from their homes, usually involving long walks to a water source (Weinger & Akuri, 2007) where there is no assurance of its quality.

2.5.8 Community level factors

Some complex factors operate beyond the individual level. This makes solely individual level assessments insufficient in capturing the dynamics of maternal mortality within communities. These factors function at family/household and community levels to impact the outcome of

maternal mortality. Community and socioeconomic status indicators, as collective resources, influence the outcome of maternal mortality at the individual level.

Community education and community wealth may determine maternal mortality in Cameroon. In Poland, living in a community with a high proportion of educated people, increased an individual's chance of exposure to others' behaviors such as low fertility preference (Colleran, Jasienska, Nenko, Galbarczyk, & Mace, 2014). For instance, a poorly educated woman living in a less educated community was predicted to have twice as many children compared to a poorly educated woman living in a highly educated community. Also, community level education influences the makeup of a woman's social network. A less educated woman living in a highly educated community has a social network of highly educated partners who may influence her health behavior. In Bangladesh, higher community knowledge of HIV was associated with increased use of antenatal care services (Stephenson & Elfstrom, 2012).

Also, a community's ethnic diversity can influence maternal mortality. In Nigeria, it was found that women living in very diverse communities (communities with a high proportion of women from different ethnic groups) were less likely to deliver at health facilities compared to less diverse communities (Ononokpono & Odimegwu, 2014). In Malawi and Zambia, an increase in the proportion of ethnic groups within a community was associated with HIV prevalence (Brodish, 2013).

Community wealth, on the other hand, is positively associated with maternal health outcomes. For instance, high community wealth (socioeconomic status), was associated with better access to health care in Rwanda (Stephenson & Elfstrom, 2012). Higher mean community income in Madagascar, was linked with fewer maternal deaths (Hernandez & Moser, 2013) while higher community employment ratio (ratio of men to women employed in the community) in Rwanda, had more women who received care during early pregnancy (Stephenson & Elfstrom, 2012).

Community resources can influence maternal health outcomes for women (McCarthy & Maine, 1992). Some of these resources are the proportion of health professionals, health facilities and services in the communities. In Ethiopia, women who resided in communities with a high rate of antenatal care service utilization were more likely to deliver at health facilities than women in communities with lower rate of service use (Mekonnen, Lerebo, Gebrehiwot, & Abadura, 2015).

These community factors may have similar associations with maternal health outcomes in Cameroon.

2.6 Geographic variation of maternal mortality in developing countries

The determinants of maternal mortality are well known. However, the factors that drive maternal mortality in one place may not be those found in another place. Variations between and within countries make it a challenging task to identify maternal mortality determinants particular to one region. This helps to explain the failure or poor performance of interventions that have been successful in decreasing maternal deaths in other places. Their poor performance may be because these interventions were implemented without consideration of contextual factors. Some successful vertical programs – disease specific programs – have performed poorly in Low and Middle Income Countries (LMICs). These programs did not improve access to care in their target population (De Maeseneer et al., 2008). For instance, the proven successes of modern contraception programs in reducing maternal death in certain parts of the world have not been seen in regions with high maternal deaths like sub-Saharan Africa where approval of the intervention is low (Cleland, Ndugwa, & Zulu, 2010).

Also, geographic variations exist for other risk factors like age and parity that have been linked with maternal death in several studies. Such associations were not found in a Guinea-Bissau study where lack of care and inadequate health services were the strongest predictors of maternal mortality (Hoj et al., 2002). Conversely, maternal mortality was high in very young or old women and in first pregnancy in Matlab, Bangladesh. However, the marked decline in maternal mortality over 30 years, was attributed to increase in education and not to the move from homebirths to facility-based births (Chowdhury et al., 2007).

In Nigeria, maternal mortality remains high (Hogan et al., 2010) with a national average of 630 deaths per 100,000 live births in 2010 (UNICEF, 2013). However, the Multiple Indicators Cluster Survey (MICS) of 1999 showed a wide variation in the level of maternal mortality within Nigeria. The South West had a maternal mortality ratio of 166 per 100,000 live births while in the North East, there were 1,549 maternal deaths per 100,000 live births (Lanre-Abass, 2008). Women from the North East and South West were less likely to use government facilities for

childbirth compared to women in the North Central region of Nigeria (Aremu et al., 2011). This means that the impact of factors that influence maternal health outcomes for the women in each of these regions varied. National level estimates alone essentially mask the regional variations and burden of maternal mortality and its determinants within Nigeria.

Maternal mortality was higher in urban areas compared to rural areas of Iran; a possible explanation is that women in rural areas had better access to primary health care compared to those in urban areas (Poorolajal et al., 2014). Women in the urban areas however, had better access to technical care within secondary and tertiary health care. Urban and rural differences in maternal mortality exist in many developing countries (WHO, 2016b). These include many African countries like Egypt, Ivory Coast, Mali, Burkina Faso, Senegal, Tanzania, Guinea Bissau and Congo (Ronsmans & Graham, 2006). These studies show how maternal mortality varies within and between countries, which may be the case in Cameroon.

2.7 Cameroon- background

2.7.1 Geography

The republic of Cameroon is located at the end of the Gulf of Guinea in West/Central Africa and is bordered by Nigeria to the west, Chad to the North-East, Central African Republic to the East and to the South by Equatorial Guinea, Gabon and Congo (Mbaku, 2005). There are 10 administrative regions in Cameroon. These regions (regional capital) are, the Far-North (Maroua), North (Garoua), Adamawa (Ngoundéré), East (Bertoua), South (Ebolowa), Centre (Yaoundé), Littoral (Douala), South-West (Buea), North-West (Bamenda), and West (Bafoussam) (Republic of Cameroon, n.d.). Yaoundé and Douala serve as the administrative and economic capitals respectively. Often called “Africa in miniature” for its diversity in peoples and geography, Cameroon has several agro-ecological regions (Institut National de la Statistique & ICF International, 2012). It is also a country that is susceptible to natural disasters such as toxic gases released from crater lakes, an active volcano (Mt. Cameroon), and landslides that impact the health and economy of communities (Bang, 2013).

Figure 1: Map of Cameroon



Source: DHS 2011 (Institut National de la Statistique. - ICF, 2012)

2.7.2 The North and South

The country is broadly bisected about the center by the Adamawa Plateau, north of which are predominantly the Fulani and Kirdi (Sudanese) people, and to the south are largely the Highlanders and Bantu people (Spedini et al., 1999). This divide gives the country 2 large northern and southern areas with varying demographic, climatic, geographic and religious characteristics (Institut National de la Statistique & ICF International, 2012).

The people of northern Cameroon are generally Muslim or animist with a heavy Sudanese presence who dominate the economic, political, religious and cultural activities particularly in the capital cities (Mbaku, 2005). The North is said to be home to some of the poorest people in Cameroon (Nguetse Tegoum, 2009); poor land use for subsistence farming and overgrazing from nomadic herdsman make accommodation for a growing population more challenging (Techoro, 2013).

The northern area consists of 3 regions (Far-North, North and Adamawa) which were one Northern Province until 1983. This area of Cameroon is a savanna and steppe (Sudano-Sahel) zone with a hot and dry tropical climate (Mbaku, 2005). Rainfall in this part of the country is sporadic and lessens further up north. The area is arable for crops like cotton, onions, peanuts, potatoes, millet and cattle ranching. This part of the country suffers from intermittent famine, due primarily to prolonged dry seasons, and crop destruction by locusts and granivorous birds (Institut National de la Statistique & ICF International, 2012).

The people of the southern portion (South) of Cameroon are primarily Christian and animist and Bantu. The western highlands and the southern forest areas together form the South. These include the North-West, West, East, South, Centre, Littoral, and South-West regions. The rich volcanic soils in this part of the country favor horticulture and the cultivation of coffee, cacao, oil palms, banana, rubber trees, and tobacco (Institut National de la Statistique & ICF International, 2012). The climate here is mostly favorable ranging from cool to hot and humid. The dense vegetation, vast river system and abundant rainfall make this one of the wettest areas in the world, and differentiates the south from the northern half of the country.

The southern part of the country is often plagued with transportation difficulties during the rainy season due to unusable damaged roads, making some areas of the country unreachable (Mbaku, 2005). The southern half is also the more metropolitan part of the country with urban centers including the capital of the country, Yaoundé, and the economic capital, Douala. Other major cities lead industrial activities, hydro-electricity centers, and gas and petroleum production. In this study, North refers to the 3 northern regions and South represents the 7 regions to the south.

Figure 2: Map of Cameroon by Northern (North) and Southern (South) regions



2.7.3 Population

Ethnicity:

Cameroon is populated by ethnic groups with unique sociocultural values and practices. The country's rich ethnocultural diversity boasts over 200 ethnic groups clustered as Highlanders (31%), Equatorial Bantu (19%), Kirdi (11%), Fulani (10%), North-Western Bantu (8%), Eastern Nigritic (7%) and others (14%) (Central Intelligence Agency, 2016). These smaller groups make up the 3 main ethnic groups of Bantus, semi-Bantus and Sudanese (Republic of Cameroon, 2016). Cameroon's population is estimated at 24 million with a 2.58% growth rate and 18 years median age (Central Intelligence Agency, 2017). The population is largely young with about 60% aged 25 years or younger, a 58 years life expectancy at birth for the population and 59 and 57 years for females and males separately (Central Intelligence Agency, 2016).

Languages:

Several languages are spoken in Cameroon. They include many tribal dialects, Pidgin (English based creole), traces of German, Spanish, and two official languages (French and English) (Fongwa, 2002; Republic of Cameroon, 2016). French remains the dominant language in eight of the ten regions. The other two regions speak English. Before independence and reunification of the two Cameroon territories, France ruled the French Cameroon territory while the British Cameroon territory was governed together with Nigeria by Britain.

Historical governance by France and Britain shaped the structure of all post-independence systems, including education and healthcare, in the country (Fongwa, 2002). Though not every Cameroonian speaks either or both languages, these two are used in formal education and are markers for literacy. Typically, people who cannot read or write in English or French use Pidgin and local dialects. The many local dialects challenge health care planners, executors and evaluators of programs of healthcare (Fongwa, 2002).

Gender relations:

Some customary laws in Cameroon promote gender equality. However, women still face several challenges to achieving equality (Commonwealth Foundation, 2015) due in part to shortcomings

of these laws and the dictates of traditional institutions, that still foster patriarchal values (UN Economic Commission for Africa, 2010). In 2015, an estimated 75% of Cameroonians aged 15 years and older were literate. However, there are differences in the proportion of educated men and women. Though education of girls is highly encouraged, only 68.9% of women are able to read and write compared to 81.2% men (Central Intelligence Agency, 2016). This is indicative of the cultural norm of girls being prepared for marriage and boys being educated (UN Economic Commission for Africa, 2010). Also, early marriage is pervasive in Cameroon and is enabled by laws that sanction marriage for girls at 15 years and boys at 18 years and are permissive of polygamy (Institut National de la Statistique & ICF International, 2012).

Religion:

Religion is freely practiced in Cameroon with religious freedom protected by constitutional law (U.S. Department of State, 2011). Christianity, Animism and Islam make up the three major religions. Christianity being the largest religion in the country consists of Catholic (38.4%), Protestant (26.3%) and other Christian (such as nondenominational Christians 4.5%). This is followed by Muslim (20.9%), animist (5.6%), others (believers of other religious traditions 4.2%) (Central Intelligence Agency, 2016).

2.7.4 Political climate

Cameroon has a centralized multiparty system of governance with a general disconnect among sectors and lack of transparency among political leaders (Commonwealth Foundation, 2015). Political power rests heavily in the hands of the president who is also leader of the ruling party (Central Intelligence Agency, 2017). The government's overreaching power has led to accusations of human rights violations (U.S Department of State, 2007). The system of governance equally hinges on indigenous systems like chieftaincies through which political leaders exert control on local people (Eyoh, 1998). Ethnic awareness is especially strong among Cameroonians and is tied to the ten regions (Eyoh, 1998; Monga, 2000). The stark differences in culture, systems of beliefs, social structures and geographic ethnic ties further embed ethnic identity in the political fiber of Cameroon. Presently, the president's ethnic group (Bulu, a subgroup of Beti ethnic group) dominates the government, state-owned businesses and security

forces (U.S Department of State, 2007). Efforts for fair representation of all ethnic groups in all sectors of state affairs (Monga, 2000), play out differently. An ethnic group's political influence determines its resources (Nyamnjoh, 1999), thereby putting minority groups with little power at a persistent disadvantage. This may explain why some regions are better developed in terms of infrastructure than others while operating under one central administration.

2.7.5 Economy

Cameroon's economy is bolstered by oil and agriculture. It has a GDP per capita of 3300 US dollars (2016) (Central Intelligence Agency, 2017). Falling oil and cash crop prices put Cameroon's economy in crisis between 1984 and 1993 (Nguetse Tegoum, 2009). This led to the Structural Adjustment Program (SAP), under which layoffs and salary cuts affected about 60% of workers in all sectors (Pongou, Salomon, & Ezzati, 2006). The reduction of program budgets, particularly public funding for health care, and rising poverty characterized the economic climate (Commonwealth Foundation, 2015; Pongou et al., 2006). Gains in the improvement of trade between rural areas and urban centers were either reversed or stagnated because of falling prices (Amin & Dubois, 2001; Pongou et al., 2006). A persistent consequence of the unstable economy is unemployment and underemployment of the largely young population with fluctuating rates as high as 40%. General consensus shows this number increasing as market demands for labor remain unchanged (Campos G. et al., 2013; Neneh, 2014). The recently growing economy is weakened by unfavorable business environment and poor infrastructure (Campos G. et al., 2013).

2.7.6 Healthcare system in Cameroon

Health care is available in Cameroon through public and privately funded hospitals, missionary and church services, local pharmacies and traditional health practices (Fongwa, 2002; Weinger & Akuri, 2007).

Public health care

Cameroon was one of the signatories of the Alma Ata declaration of 1978 on Primary Health Care (PHC), which included maternal health care (AbouZahr, 2003). The government had the responsibility of addressing the health needs of the country's people and developing sustainable primary health care systems. Cameroon's public health sector (see fig. 3), consists of one central

ministry, intermediate regional delegations and peripheral health districts delivering healthcare through primary, secondary and tertiary health services (Tandi et al., 2015).

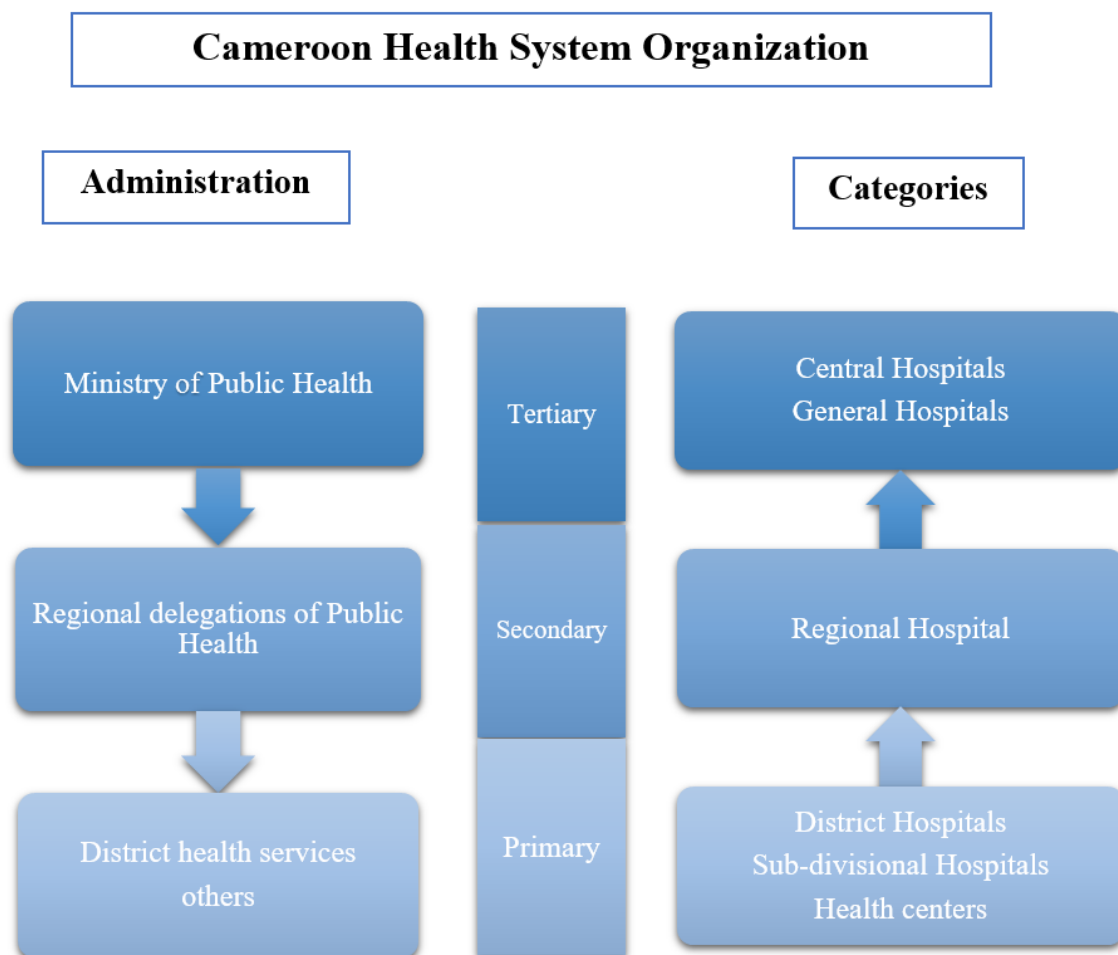
The health care system of Cameroon was also negatively affected by the Structural Adjustment Program (SAP), following the economic crises of the 1990s. It led to staff reductions, salary cuts for health care professionals and a reduction of public funding for health care (Commonwealth Foundation, 2015; Pongou et al., 2006). A health cost recovery system was introduced following the downsized capacity of the health system (Kamgnia, 2006), shifting the bulk of healthcare cost onto individuals.

The burden of healthcare cost is borne by individuals; public funds apportioned for health are insufficient, poorly distributed and mismanaged. In 2014, government expenditure on health care was 4.26% of total spending. Private expenditure was 77.13% of total expenditure on health (WHO, 2016a) while the rest was from external sources of funding from international health sponsors. A large portion of public health funds go towards the purchase and importation of pharmaceuticals, which reduces funds for other health programs (Fokunang et al., 2011). The last decade has seen minimal to no improvement in the health sector in Cameroon (Bove, Robyn, & Singh, 2013). Some studies report that about 1% of the population has health insurance (Bove et al., 2013) while others state there is no health insurance (Kongnyuy, Soskolne, & Adler, 2008). Prescriptions from government pharmacies are less expensive compared to those that are privately run (Fongwa, 2002). The publicly funded facilities are laden with outmoded technology and equipment. The few hospitals with modern equipment such as specialty care hospitals, are located in the Southern portions of Cameroon specifically in Yaoundé and Douala.

Cameroon suffers from a critical shortage and unequal distribution of health personnel (Fongwa, 2002), and fails to meet the WHO guideline of 2.5 health worker per 1000 critical shortage threshold. Cameroon has a health personnel-to-population density of 1.3 (Tandi et al., 2015). The available health care workers are concentrated in urban centers (Kingue, Roskam, Bela, Adjidja, & Codjia, 2013). The northern regions were reported to be the least represented in workforce. For instance, a physician in the Centre region attended to about 5000 persons as opposed to about 26000 in Adamawa (Tandi et al., 2015). The Centre region which has about 18% of the population of Cameroon, has 40% of Cameroon's physicians while the Far-North with an equal

population only has about 8% (Bove et al., 2013). The health worker shortage, together with the limited to no health centers in the rural areas of the country, drive up the cost of seeking healthcare; this includes time lost due to long waits, and the need to travel long distance to health facilities (Fokunang et al., 2011).

Figure 3: The Health System of Cameroon



Source: Ministry of Public Health 2011 Data (Tandi et al., 2015)

Private and traditional health care

Seeking healthcare outside the public health system is prevalent in Cameroon. Rural and poor urban residents are increasingly shifting towards the use of traditional medicinal compounds derived from plants, animals and minerals (Fokunang et al., 2011). Many turn to traditional health providers because of their unmet needs or unresolved conditions treated in the formal health system (Fongwa, 2002). The practice is especially noticeable in the West and North-West where associations of traditional practitioners are stronger (Fokunang et al., 2011) and in the Centre and East regions, where the most common ailments treated include malaria, abdominal pain and anemia (Fokunang et al., 2011; Jiofack, Fokunang, Guedje, & Kemeuze, 2009).

Traditional medicine is typical in the forested south of the country, where many medicinal plants are indigenous (Jiofack et al., 2009). Agbor & Naidoo (2011) argue that the majority of Cameroonians depend on traditional medicines, yet it is not known if either the Northern or Southern regions of the country are more dependent on them. The high cost of care relative to the socioeconomic status of the people forces this turn to traditional medicine (Weinger & Akuri, 2007) which is relatively cheaper than conventional medicine. It is worth noting that traditional health care is reported to jeopardize women's health particularly in the area of reproduction through practices such as female genital mutilation/cutting and ritualistic cutting during delivery that are often aggravated by the use of unsanitary facilities and equipment (Weinger & Akuri, 2007).

Though private and mission hospital care tends to be more expensive than public health care facilities (Weinger & Akuri, 2007), some offer services and specialty care that are missing in publicly funded hospitals (Fongwa, 2002). Traditional health service providers tend to accept payment in cash and goods (Fongwa, 2002), a practice that makes them an attractive alternative to modern healthcare services. More so, the increasing challenges of poor service quality within the public health sector (Fokunang et al., 2011), only increases the recognition and acceptance of traditional health services.

Health system challenges

The health system of Cameroon is still confronted with problems in the delivery of health to the population. This system has, to date, provided a poorly dispersed number of facilities within the country. Many health centers in rural areas are poorly equipped and understaffed, with unsupervised and undertrained workers, and plagued with high staff absences (Institut pour la Recherche de développement et la Communication, 2012). Many health centers that were created following the Alma-Ata Conference, particularly in the rural areas, have lost staff members (who were initially traditional birth attendants) due to lack of motivation, poor retention policies, and the failure of the health sector to provide training which would allow these individuals to become nurses.

Available resources (equipment and services) are underused with inadequate coverage of preventive care, poor continuum and quality of care, and insufficient referrals. For instance, Mangham et al., (2012), found that widely available microscopy for malaria diagnosis was underused. The direct sale of medicine to, and receipt of payment from, the public by staff, are prohibited practices that are still widespread (Institut pour la Recherche de développement et la Communication, 2012; Israr, Razum, Ndiforchu, & Martiny, 2000). The limited resources are spread thin and focused on issues deemed to be a priority in Cameroon: principally HIV/AIDS, malaria, tuberculosis, cancer, schistosomiasis and helminthiasis (Canadian Coalition for Global Health Research, 2014). This has led to limited or nonexistent resources for interventions in other areas of health care such as emergency health services and public health preparedness for often occurring natural disasters (floods in the south, droughts and famine in the north).

There is need for improving health provider training in Cameroon. Health providers were found to rarely seek to update their knowledge about evidence-based practices, and were unaware of key interventions to prevent maternal mortality from complications arising during childbirth (Tita, Selwyn, Waller, Kapadia, & Dongmo, 2005). Few health workers were found to be aware of the changes in malaria treatment policies (Sayang et al., 2009) and over-reliance on presumptive diagnosis of malaria is persistent among health workers (Mangham et al., 2012). Fongwa (2002), reports that nursing and medical students have limited access to books and the available books are often older editions. This is a barrier to the use of up to date evidence-based

interventions and a problem that continues into their practice because of a lack of continuous education (Tita et al., 2005). There have been cases of health workers performing illicit procedures such as surgeries, and of health professionals using technology with which they are not familiar.

Cameroon's health system faces a challenge of limited reliable data. Limited data, particularly at the district level, make it difficult to assess health problems within the population. Small scale investigations have been restricted to hospitals that have data on facility births within individual regions. Also, available data to assess quality of care within primary health care is inadequate (Fongwa, 2002) and timely data still remains a major concern (Bove et al., 2013). Government reports, deemed incomplete or to have underreported information, have led to poor assessments of health states across the country (Commonwealth Foundation, 2015).

2.7.7 Health status of the people

Self-treatment is very common in Cameroon. Prior exposure to a treatment for familiar symptoms may promote this behavior. The sale of medications and other health products directly to clients through street vendors without the provision of a prescription (Kamgnia, 2006) exacerbates this problem. Lingering distrust of vaccines and other interventions (as was evidenced in 1990 with tetanus vaccination scare) (Feldman-Savelsberg, Ndonko, & Yang, 2005; Feldman-Savelsberg, Ndonko, & Schmidt-Ehry, 2000) may have enabled this practice in part along with the high cost of healthcare.

Women, together with children, bear a heavy burden of infectious diseases (AbouZahr, 2003). In Cameroon, HIV/AIDS and malaria are among the leading causes of death and the burden of these rest disproportionately on women (Defo, 1997). Women tend to ignore their health care needs in favor of their children's (Fongwa, 2002). The position of women in society equally influences their health outcomes. Cameroon, like many countries in sub-Saharan Africa, has many cultural attributes that limit women's autonomy and self-care. For instance, maternal mortality was found to be high among the Hausa women of northern Nigeria (Wall, 1998), a population very similar to that of North Cameroon due to their cultural practices. Women are more affected by HIV/AIDS than men, with 170 infected women for every 100 infected men

(Nkuoh, Meyer, Tih, & Nkfusai, 2010). Women are reported to get infections at a younger age with more burdensome consequences than their male counterparts (AbouZahr, 2003).

Like maternal mortality, child mortality in Cameroon remains a major public health issue. It is worse than other middle income countries in the region, with minimal declines observed (Pemunta & Fubah, 2015). The 1990s saw a rise in child mortality that mirrored the effects of the economic crises on health programs funding. Between 1998 and 2004, under five years of age mortality rates of 203 and 146/1000 live births for northern regions and the Centre/South/East respectively, were observed (Pemunta & Fubah, 2015). In 2011, the rate stood at 122/1000 live births; the leading causes of death were malaria, pneumonia and diarrhea (Bove et al., 2013). Infant mortality was estimated at 52.2 deaths/1,000 live births (Central Intelligence Agency, 2017). Neonatal deaths account for about 50% of under 5 years of age mortality, occurring typically in the first month of life (Gülmezoglu et al., 2016). This points to the impact maternal mortality has on child survival, particularly in the first month of life.

Malnutrition, a close factor to child and maternal mortality, still persists in Cameroon. Nutritional outcomes were adversely affected by the economic crises in the 1990s, when there were higher proportions of malnourished children between 1991 and 1998 (Pongou et al., 2006). The northern regions were hit harder than others in Cameroon and have higher rates of malnourishment, showing a clear distinction between the North and South regions of Cameroon (Pemunta & Fubah, 2015).

2.7.8 Maternal health in Cameroon

The 1987 Safe Motherhood Initiative and 1994 International Conference on Population and Development put maternal health on the international scene and on Cameroon's health agenda. This strengthened the government's commitment to reproductive health, prompted efforts to improve maternal health and cut the high levels of mortality (AbouZahr, 2003). Cameroon adopted MDG 5 goal to cut maternal deaths by 75% between 1990-2015 (United Nations, 2015). The SDGs aim to continue this reduction in maternal mortality (United Nations, 2015). Medical and community level interventions such as skilled birth attendants and family planning services effectively curbed maternal deaths in some developing countries, but the same efforts have been weak in Cameroon, prompting a need for political leaders to devote attention to this issue.

Cameroon's interventions for maternal health:

Following the economic crises of the 1990s that led to cutbacks in healthcare services, Cameroon adopted policies for improvement in governance, a poverty reduction strategy, and recruitment of staff under the Heavily Indebted Poor Countries (HIPC) Initiative. Cameroon's economy has seen improvements in recent years, but health outcomes have remained the same or worsened. For Cameroon to get on track with SDG 3, the MMR needs to fall to 168/100,000 live births. Cameroon, among other high MMR countries, was encouraged to invest in and reinvigorate its health sector, train more medical professionals and increase the number of hospitals (Commonwealth Health Online, 2017). These recommendations are in line with the four pillars of the safe motherhood strategy which include skilled birth attendants, emergency obstetric care, antenatal care, and family planning (WHO, 1994a). In an effort to improve maternal health following these recommendations, Cameroon implemented interventions for birth control, the control of infections, increased training of health professionals and pledged to financially support these interventions.

Modern contraception

As one strategy for cutting maternal mortality (through reduction in the number of births), modern contraception has led to marked declines in maternal mortality in some South American and Asian countries (WHO, 2015). Cameroon pledged to take similar steps with a goal to increase the use of modern contraception to reduce the country's high fertility rate and levels of maternal mortality. The government committed to devote resources to vulnerable populations, reduce unmet needs for family planning and increase budget allocations for modern contraception. In 2000, the baseline year for MDG 5, modern methods of contraception were prioritized as the principal and cost effective intervention for maternal mortality in Cameroon. By scaling-up the stocks of modern contraceptives, the government hoped to double the prevalence of modern contraception use by the year 2020 (République du Cameroun MINSANTE, 2015).

Infection control

To reduce the impact of infectious diseases like malaria and HIV in pregnant women, Cameroon adopted infection control measures. Insecticide treated bed nets (ITNs) and Long Lasting Insecticide-treated Nets (LLINs) were distributed as tools for controlling malaria infection by the National Malaria Control Program (NMCP) in Cameroon. Initially, priority was given to pregnant women and children, but later, the entire population was covered (Tchinda et al., 2012). Data on use is limited but effective usage of treated nets is expected to reduce infection. The government also organized workshops for health workers in all regions to facilitate changes on the first line and alternative therapies for malaria in 2004 and 2006 respectively (Mangham et al., 2012). Special recommendations were made for the treatment of pregnant women presenting with malaria (Mangham et al., 2012).

HIV was the leading cause of death in 2012 in Cameroon (WHO, 2015) and together with malaria, presents a real challenge for maternal health. HIV may also be the reason why Cameroon lost ground on the reduction of maternal mortality (Egbe et al., 2016). Urban areas are particularly challenged by HIV/AIDS and only about 46.5% of people with advanced HIV infections have access to antiretroviral therapy. Cameroon has therefore, focused on the prevention of HIV infection, blood safety and the prevention of mother to child transmission (PMTCT). These HIV preventive measures are integrated into the maternal and neonatal care programs of about 555 clinics in Cameroon which also deliver Anti-Retroviral (ARVs) therapy for HIV infected pregnant women (Centers for Disease Control and Prevention, 2016).

Training of health professionals

Cameroon has a severe shortage of midwives as evidenced by a rate of 0.2 midwives per 1000 live births (2011). In 2011, the government embarked on training medical personnel, particularly midwives, to meet the WHO/UNFPA recommendations for a 6-15 fold increase (United Nations Population Fund, 2011). This is considered a long term investment (Lawson & Keirse, 2013). The government pledged to train about 200 midwives a year (Every Woman Every Child, 2016) and created schools of midwifery across the country. Health workers are also trained in comprehensive emergency obstetric care (United Nations Population Fund, 2011) and HIV service delivery (Centers for Disease Control and Prevention, 2016).

Local and international commitments

Cameroon's commitment to reduce maternal mortality includes providing financial and technical resources. In 2011, Cameroon pledged a 5% annual increase in the health budget for interventions such as modern contraception and financial incentives for the retention of health workers in rural settings (Every Woman Every Child, 2016). A small proportion (0.7%) of the health budget was directed towards research. This is inadequate support for research and so, many research projects in the country are supported by foreign aid (Canadian Coalition for Global Health Research, 2014). Foreign aid from the international community supports efforts to improve maternal health and reduce maternal mortality. For instance, UNFPA and CDC offer technical support to Cameroon which sustains the health system. The UN's specific commitments began with the safe motherhood initiative of 1987 for women's health (Abou-Zahr & Royston, 1991; AbouZahr, 2003), and later to the Partnership for Maternal, Newborn and Child Health 2005, Every Woman Every Child in 2010, and the Commission on Information and Accountability for Women's and Children's Health 2010 (Kassebaum et al., 2014).

2.8 Maternal mortality in Cameroon

Not every country has seen a decline in maternal mortality, and many fell short of the 2015 goal. Indeed, Cameroon saw a rise in maternal deaths with 782 maternal deaths /100,000 live births in 2011 (République du Cameroun MINSANTE, 2015). Previously, maternal mortality ratios were 669/100,000 and 454/100,000 live births in 2004 and 1998 respectively (Barrère, 2004).

Similarly, there was a rise in maternal deaths in terms of maternal mortality rates in Cameroon. In 2004, the maternal mortality rate was 1.16/1000 compared to 0.85/1000 women of reproductive age in 1998 (Barrère, 2004). The estimate for 2011 was even higher at 1.33/1000. Further assessments confirm the dismal situation, with an estimated 304 birth complications a day, and a 1 in 35 lifetime risk of maternal death in Cameroon (United Nations Population Fund, 2011).

Health facilities show varying levels of maternal mortality. In Maroua (city in the North of Cameroon), a hospital-based study reported 1266 maternal deaths/100,000 livebirths for deaths that occurred between 2003-2005 (Tebeu, Ngassa, Kouam, Major, & Fomulu, 2007) while the South West region (in the South of Cameroon) had 892 maternal deaths /100,000 livebirths

(Ekane et al., 2014). Within tertiary health facilities in the capital and economic capital cities of Yaoundé and Douala (in the South), similar variations were seen in maternal mortality ratios ranging from 264 to 1,116 death per 100,000 livebirths (Mbassi et al., 2011). These levels, however, remain unique to the women that used these health facilities and are not necessarily representative of the levels of maternal mortality in the North or South of Cameroon. Maternal mortality ratios derived from hospital based data are extrapolated to the country level (Tebeu et al., 2007). This is because maternal mortality is under-reported in Cameroon due to inadequate registry data limiting the country's capacity to assess maternal mortality at the regional and national levels. Cameroon therefore relies on population-based data from surveys to measure maternal death.

Cameroon did not meet its MDG 5 target in 2015 (Commonwealth Foundation, 2015; Egbe et al., 2016) and stands further challenged by the even more ambitious SDG 3. With a predominantly young population, about 60% of whom are under age 25 years, a high fertility rate of 5.1 children per woman, and one-third of women having their first child before age 18 years (République du Cameroun MINSANTE, 2015), high maternal death rates may persist or steadily increase. This profile, which unfortunately prevails in other sub-Saharan countries like Chad and Somalia, places Cameroon among the African countries with the worst burden of maternal death in the world.

2.8.1 Recap of determinants of maternal mortality in Cameroon

Literature assessing determinants of maternal mortality in Cameroon is sparse. The few studies that exist are health facility-based (Doh, Nasah, & Kamdom-Moyo, 1989; Ekane et al., 2014; Fouelifack et al., 2014; Mbassi et al., 2011; Pierre-Marie et al., 2015; Tebeu et al., 2007), and community-based (Egbe et al., 2016). These facility-based studies highlighted causes (direct and indirect) of maternal death that are consistent with those established for Sub-Saharan Africa (hemorrhage, hypertensive disorders and sepsis).

Some determinants were found to be associated with maternal mortality within these health facilities. Mbassi et al. (2011) assessed obstetric complications in seven health centers in the South of Cameroon and found associations between age, parity, and socioeconomic status, and maternal mortality. Age was also significant in a health facility studies in the North (Pierre-

Marie et al., 2015; Tebeu et al., 2007). Pierre-Marie et al. (2015) found that maternal mortality was significantly associated with no attendance for antenatal care. Similarly, Ekane et al. (2014) found associations between maternal mortality and having no antenatal care, age less than 35 years, and unemployment. Another study found that having been referred, past preterm deliveries and grand multiparity increased the odds of maternal mortality in a health facility in Yaoundé (Fouelifack et al., 2014).

A community based study in Mezam (located in South Cameroon), found no association between maternal mortality and age and parity. Instead, a high prevalence of unsafe abortions, an increased likelihood of home delivery, the use of traditional birth attendants, and taking over one hour to get to a health facility or hospital were found to be significant risk factors for maternal death (Egbe et al., 2016).

Though the determinants of maternal mortality have been established on the global scale, the significant determinants in Cameroon have not been extensively documented. The rising level of maternal deaths points to a growing problem for maternal health in Cameroon. If this persists, Cameroon may miss its goal of reducing maternal mortality. Given the differences that exist between the North and South of Cameroon, the level of maternal mortality and its determinants may differ between the two regions. However, these have not been explored in Cameroon. Hence it is not known if the North and South differ on maternal mortality in terms of its levels (maternal mortality rates and ratios) and determinants.

2.9 Current study

Aim and rationale:

Even with national scale interventions, maternal deaths remain critically high in Cameroon. Having lost ground on MDG 5 with an unyielding level of maternal mortality, there is need to explore the pertinent factors driving maternal mortality in Cameroon. This is essential for progress towards the reduction of maternal deaths in Cameroon. The aim of this study was to assess differences in the levels and determinants of maternal mortality among women of childbearing age (15-49 years) using the Demographic and Health Surveys of 2011 and 2004.

Specifically, within country levels and determinants of maternal mortality will be compared between the North and South of Cameroon.

The North and South are the most distinct regions of Cameroon, which have very diverse socioeconomic, cultural, religious, individual and geographical factors. Studies show that determinants of maternal mortality vary between and within countries and that geographic disparities also influence the level of maternal mortality and the prominence of risk factors within the population. Yet, there is scant evidence on the determinants of maternal mortality in the North and South. Also, large population based studies, which are best suited for capturing rare events like maternal death are limited in Cameroon.

To date, the few studies undertaken have been hospital or health facility based. These tend to only capture a subset of the population, missing deaths occurring after discharge from a health facility and for women who did not use these facilities. Findings derived from these studies represent specific groups or districts but are seldom generalizable to the rest of the country.

The study objectives were to:

1. Estimate the 2004 and 2011 maternal mortality rate and ratios for the North and South of Cameroon.
2. Assess whether the North and South of Cameroon differ in terms of determinants of maternal mortality.

Specific research questions:

1. *What are the maternal mortality rates and ratios for the North and South of Cameroon in 2004 and 2011?*
2. *What determinants influence maternal mortality in Cameroon?*

With the adoption of MDG 5 in 2000, maternal mortality was chosen as an indicator towards progress on this goal. Since then, signatory countries, among which was Cameroon, implemented a variety of programs to reduce maternal mortality. These programs have led to changes in the

levels and determinants of maternal mortality in some of these countries. It is, however, not known whether determinants of maternal mortality changed in Cameroon post MDG adoption. Existing national level data on maternal mortality from surveys in 2004 and 2011 permit the assessment of this next question:

3. Did determinants of maternal mortality in Cameroon change between 2004 and 2011?

There are geographical variations in determinants of maternal mortality. Given the distinct nature of the North and South of Cameroon, the following research question was posed:

4. Do the women of the North and South regions differ on the determinants of maternal mortality?

Significance of study

It is important to determine the levels of maternal mortality and to understand if and how its risk factors vary between the North and South regions of Cameroon. As yet, no known studies have examined these the two regions for differences in maternal mortality. This study is the first to assess variants between the northern and southern regions at the individual and community levels using a novel approach (ascribing sibling characteristics to deceased women) using a large representative dataset. This approach assumes that respondents and deceased siblings are similar on specific factors. Family members' characteristics have been used in other studies to assess satisfaction with healthcare (Wright et al., 2015). The findings from this study could inform national and regional policies for improving maternal health outcomes in Cameroon, by addressing an existing gap in knowledge within the literature on maternal mortality.

This within-country approach affords Cameroon an assessment within itself unlike comparisons to other countries. The maternal mortality ratio (MMR) is an indicator of social development and the overall wellbeing of women. Obtaining the MMR for the North and South regions of Cameroon can shed light on the changes of maternal death within the country, thus indirectly assessing the measures that have so far been adopted to improve maternal health.

Health care programs must be supported by strong health policies. While these policies may be sound, as have been the case in Cameroon, the breadth of evidence to properly guide their creation and adoption is limited.

Chapter 3: Methods

3 Conceptual framework, data and methodology

This chapter focuses on the procedures and techniques used to assess determinants of maternal mortality in the North and South of Cameroon. It begins with an overview and description of the selected conceptual framework, its relevance for this study and how it was operationalized. Also, the data source, the type of data, the sampling design and the data collection method and tools are described. Next, the sample is described including the steps taken to identify eligible participants by survival status and parity. Finally, the steps used to recode the variables selected for analysis study population, and the statistical methods are described in detail.

3.1 Conceptual framework

Effective interventions for the reduction of maternal mortality are based on evidence obtained through models that guide the study and understanding of the relationship between determinants and the outcome. For the analysis of determinants of maternal mortality in Cameroon, potential frameworks were reviewed, and an appropriate framework was selected.

3.1.1 Conceptual framework for determinants of maternal mortality

The development of theoretical models and conceptual frameworks have greatly enhanced our understanding of determinants of maternal mortality. One framework is the ‘three delays’ framework. This model guides research and practice by focusing on delays (in seeking care, arrival at facility and provision of care) following the onset of complications (Thaddeus & Maine, 1994) as the main determinant of maternal mortality. It explores the gaps that prevent women from accessing care between the onset of obstetric complications and the outcome (mortality or morbidity). Its premise is that without delay, most complications (which are often emergencies and unpredictable) (Filippi et al., 2016) can be treated leading to better maternal outcomes. This model was expanded to include the ‘near miss approach’ to identify critical events around childbirth in women who survived complications (Pacagnella et al., 2012).

Another model for understanding the determinants of maternal mortality is the rights-based approach which looks at the legal, cultural and social context of access to health services where lack of autonomy and other restrictions that affect women, health systems and governments, may explain the occurrence of some maternal deaths (Freedman, 2001). It holds that women's ability to control the timing of pregnancy is a key factor in the reduction of maternal mortality. These frameworks are useful for the analysis of specific factors, but they only provide a partial view of the determinants of maternal mortality.

McCarthy and Maine's framework is inclusive of most determinants pertinent to maternal health outcomes. By integrating the roles of socioeconomic, cultural, behavioral and biological factors, this model affords a more comprehensive approach to understanding the relationship between determinants and maternal mortality. It has also been extensively used in research to guide analyses of determinants of maternal mortality and morbidity. For instance, the McCarthy and Maine framework was used in the assessment of skilled birth attendants' competence in managing obstetric complications in 5 high mortality settings (Harvey et al., 2007); the evaluation of health equity programs in Ethiopia (Karim et al., 2015); analysis of the effect of cash transfers on determinants of maternal mortality in Indonesia (Kusuma, Cohen, McConnell, & Berman, 2016), understanding factors affecting health facility childbirth in Kenya, Tanzania and Zambia (Ng'anjo Phiri et al., 2014), and is referenced by WHO as a useful tool for the analysis of avoidable factors of maternal death (WHO, 2004a). It was therefore chosen as the conceptual framework for this thesis.

3.1.2 McCarthy and Maine's framework for analyzing the determinants of maternal mortality

A multitude of factors contribute to the occurrence of maternal deaths. McCarthy & Maine's (1992) framework (see figure 4) groups these factors into biological, social, economic, cultural, behavioral and environmental categories or domains. This framework proposes a mechanism through which these factors contribute to maternal mortality. The interaction of these factors directly or indirectly leads to maternal death, pregnancy complications and morbidity; thus highlighting specific pathways for interventions to prevent these outcomes. The proximity of these factors emphasizes their level of influence on the outcome, with distant factors underlying the intermediate and proximal factors.

The determinants of maternal mortality in this framework are categorized as distant or intermediate determinants. Intermediate determinants directly influence a woman's likelihood of becoming pregnant, developing a complication and dying as a result. They include health and reproductive status, health and behavior, and access to health services. Distant determinants of maternal mortality like socioeconomic and sociocultural factors have an indirect influence on mortality. Their influence works through intermediate factors to affect maternal health outcome (McCarthy, 1997).

3.1.3 Determinants of maternal mortality in McCarthy and Maine's framework

In this section, the factors (determinants and outcomes), as are presented in the McCarthy & Maine's "A framework for analyzing the determinants of maternal mortality" are examined below. First, the outcomes are described, followed by an overview of both the intermediate and distant determinants.

Outcomes

Maternal death is only classed as such when there was a pregnancy within a specific period before death (McCarthy & Maine, 1992). Pregnancy is the base for all other factors associated with maternal death or morbidity. There are risks associated with pregnancy that vary for each woman and between women in different communities. These risks may result in complications during pregnancy, delivery or the postpartum period (Abou-Zahr & Royston, 1991; McCarthy & Maine, 1992; Wall, 1998). The majority of maternal deaths in many African countries have been associated with complications arising from abortions, bleeding and prolonged labor (Kassebaum et al., 2014).

Intermediate determinants

A woman's health status is critical for maternal health. This is measured by her nutritional status, and the presence of infections or other chronic diseases. Anemia and a child's weight at birth are measures for women's nutritional status (Mbassi et al., 2011; McCarthy & Maine, 1992) particularly in settings where more direct measures are unavailable. Infections such as HIV/AIDS and malaria have devastating outcomes for pregnant women (Abou-Zahr & Royston, 1991; Buor & Bream, 2004; Mbassi et al., 2011; McCarthy & Maine, 1992; Wall, 1998).

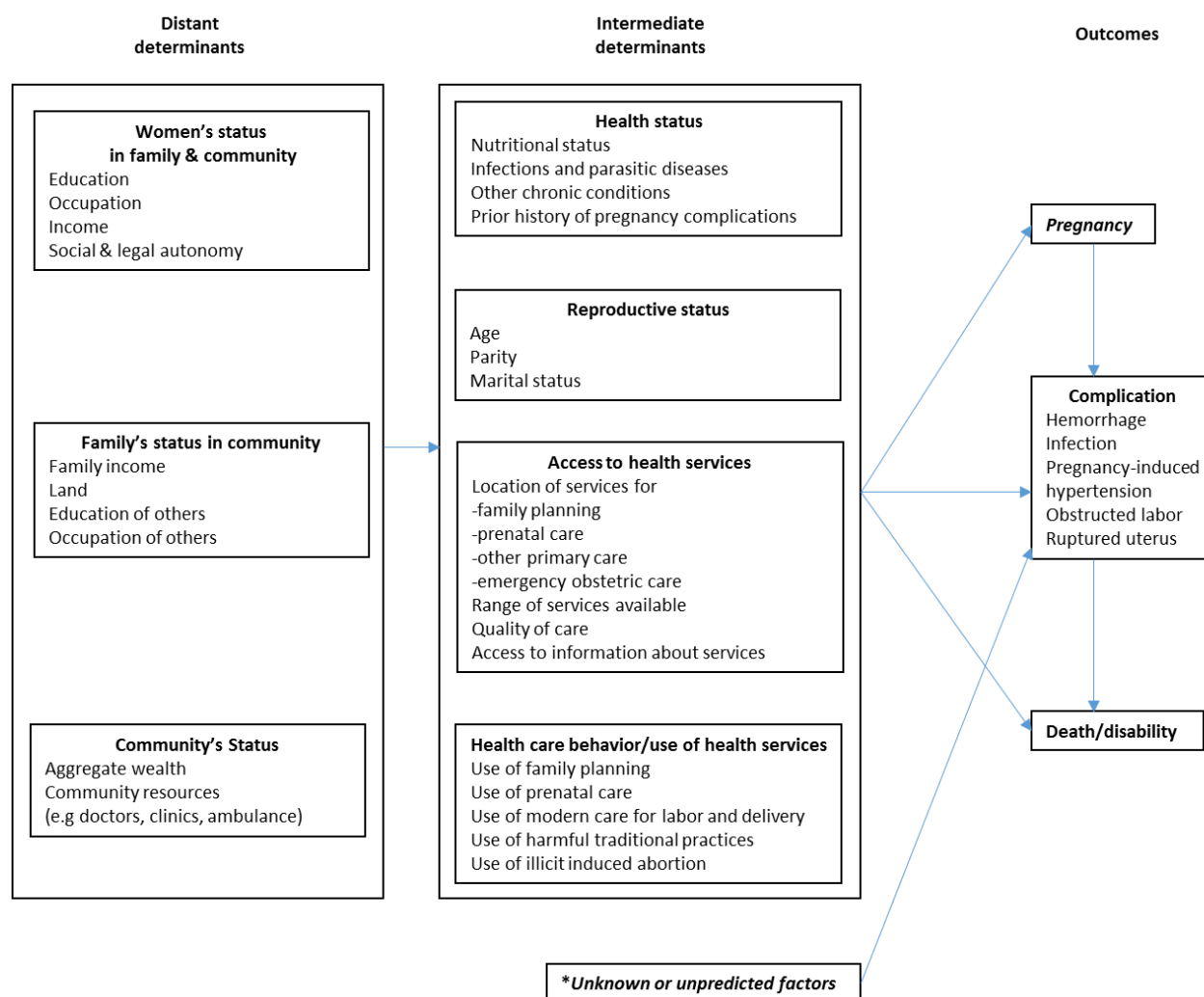
Furthermore, the existence of chronic conditions such as diabetes and hypertension or the presence of previous complications from an earlier pregnancy may affect the outcome of a pregnancy or delivery (McCarthy & Maine, 1992).

Maternal and women's health services play an integral role in preventing the occurrence of maternal deaths. A wide range of services available (Chimfutumba et al., 2015) and a high quality of care ensure the coverage of women's needs through antenatal care, attended by skilled health personnel (Alvarez et al., 2009; Buor & Bream, 2004). The presence of skilled health personnel has been shown to reduce the rate of maternal mortality (Buor & Bream, 2004). Lack of informational services for women in many health centers in countries such as Cameroon may explain the low use of modern contraception. The use of illicit abortion services suggests a problem of unmet health needs in terms of the number of unwanted pregnancies (McCarthy & Maine, 1992). Abortions could be spontaneous or induced with the latter having been associated with intimate partner violence (Alio et al., 2011; Chimfutumba et al., 2015; McCarthy & Maine, 1992; Stöckl, Filippi, Watts, & Mbwambo, 2012).

Distant determinants

Maternal mortality is also influenced by the socioeconomic status of a woman and that of the members of a woman's social support system. Income, occupation and possession of land reflect a family's standing in a community (McCarthy & Maine, 1992). Possessions such as mode of transport, refrigerator, electricity and good housing quality indicate better socioeconomic standing which may improve a woman's health status by easing her access and use of health services. Low standing in community, reflected partly in poor housing and lack of these resources, is detrimental to health.

Figure 4: McCarthy & Maine “Framework for Analyzing the Determinants of Maternal Mortality”



Source: McCarthy, James and Deborah Maine. 1992. "A framework for analyzing the determinants of maternal mortality," *Studies in Family Planning* 23(1): 23–33.

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3.1.4 Adapting the McCarthy & Maine framework.

The framework was adapted to suit the purpose of this thesis. This occurred at 2 levels.

a) Addition of variables/domains

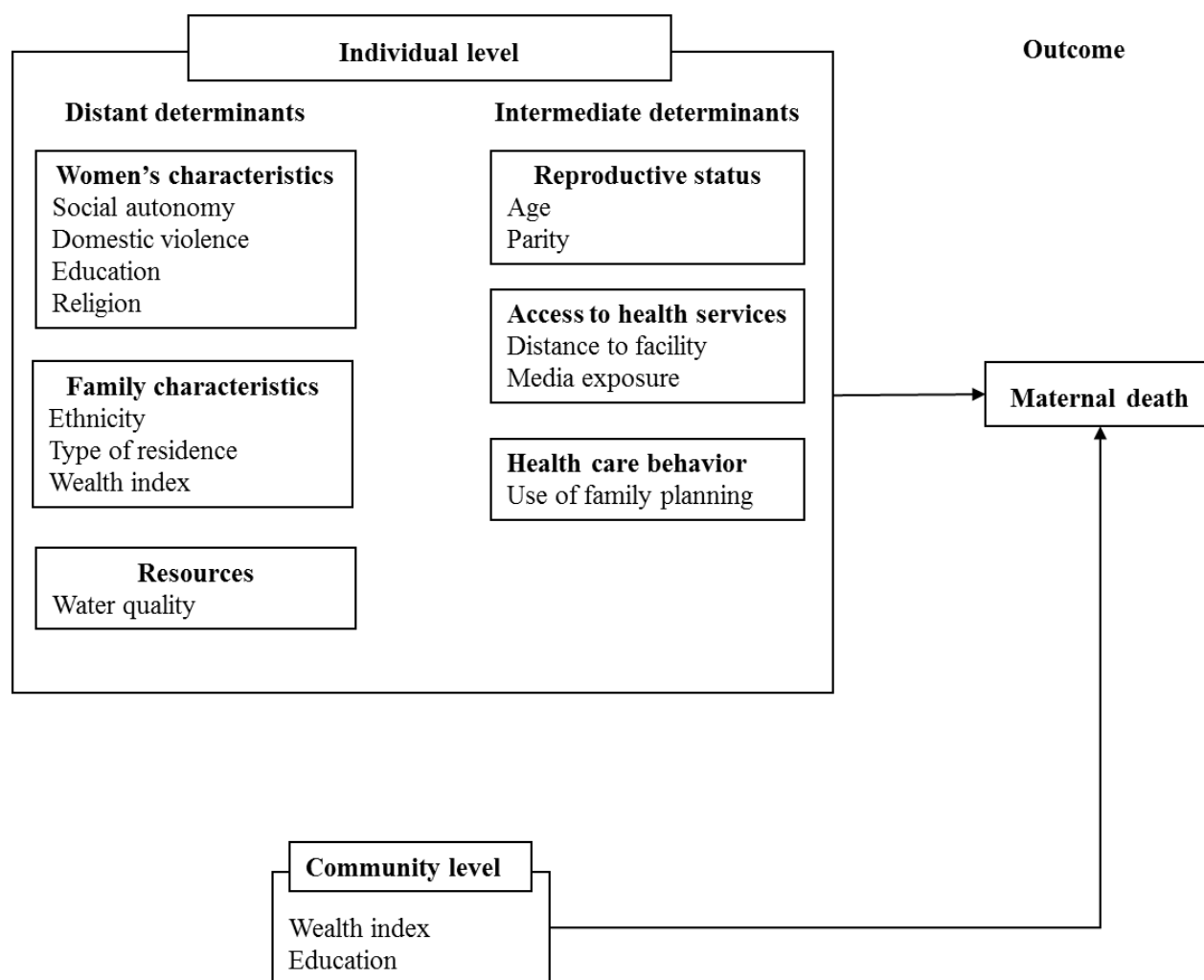
McCarthy and Maine (1992) recognized that the determinants in their framework were not exhaustive of all the determinants of maternal mortality thereby allowing for the addition of other factors. Thus, determinants of maternal mortality as were available from the Cameroon Demographic and Health Surveys (CDHS) and suitable for this study were included. These included additional female characteristics (domestic violence, ethnicity and religion) that have been associated with maternal health outcomes. These factors fit the context of this study, were equally established as determinants of maternal mortality and were available in the CDHS dataset. The determinants in the adapted framework were further categorized by grouping factors at the individual and community levels. This was to capture the complexities of factors that have been shown in literature to operate at both levels.

b) Dropping variables/domains

McCarthy and Maine's model was further modified by dropping some domains and variables. The domains on complication (hemorrhage, infection, pregnancy-induced hypertension, obstructed labor and ruptured uterus) and health status (encompasses nutritional status, infections, chronic conditions and previous pregnancy complications) were excluded. These were omitted from the final model because they were unavailable in the DHS or were missing for some of the study participants. Also, some variables (such as marital status, occupation, and land) were dropped from the domains that were retained in the final model.

The analysis of determinants of maternal mortality in Cameroon was thereby guided by an adapted framework which included determinants of maternal mortality from all the important domains of the McCarthy and Maine framework. The variables included covered each domain adequately.

Figure 5: Adapted Framework (McCarthy & Maine) Determinants of Maternal Mortality in Cameroon



Adapted from (McCarthy & Maine, 1992)

3.2 Data source

The Demographic and Health Surveys (DHS) are nationally representative household surveys for population, health, and nutrition indicators (ICF International, 2016). Comprising over 300 surveys in more than 90 countries, the DHS provides important evidence about global health and population trends in developing countries, particularly in the areas of maternal and child health,

family planning and fertility, gender, malaria, nutrition and HIV/AIDS (DHS, n.d.-c). This information is a source for policy development around the world regarding population and health programs in Low and Middle Income Countries (LMICs) (Corsi, Neuman, Finlay, & Subramanian, 2012). The DHS builds on the achievements of the World Fertility Survey, which previously provided similar information and was later replaced by the DHS. The DHS has since 1984 grown to include other modules such as the behavior module which assesses factors like domestic violence and alcohol consumption. The DHS assess widely differing issues pertinent to populations of individual countries.

DHS surveys are conducted every 5 to 7 years by several LMICs in partnership with the United States Agency for International Development (USAID) (Corsi et al., 2012). Standard DHS samples sizes range from 5000 to 30,000 households per country. Eligible persons often include men of ages 15-49, 15-54 or 15-59 years old, women of reproductive age 15-49 years, and children (DHS, n.d.-a). The age of participation in a DHS depends on the country specific age requirement. Each DHS survey takes approximately 18 to 20 months to implement. During this time, four core phases (survey preparation and questionnaire design, training and fieldwork, data processing, and final report and dissemination of findings) constitute the execution of the survey (DHS, n.d.-b).

3.2.1 Cameroon DHS

There are four cycles of DHS surveys (1991, 1998, 2004 and 2011) available for Cameroon. These surveys provide data on topics such as marriage, fertility levels and preferences, maternal and child health, family planning, nutritional status, infant, child and adult mortality, malaria prevalence, domestic violence, knowledge and behavior towards HIV/AIDS and maternal mortality (Institut National de la Statistique & ICF International, 2012; Institut National de la Statistique & ORC Macro, 2004a). These surveys provide the best estimates and representative information about maternal mortality and its determinants for specific periods in Cameroon.

Cameroon DHS Survey execution

The CDHS surveys were implemented by the National Institute of Statistics with technical assistance from the MEASURE DHS program. The Cameroon government, through the Ministry of Public Health and the Ministry of Economics, Planning and Regional Development provided

technical staff and logistical support. These surveys were supported financially by the Cameroonian government together with UNICEF, UNFPA, World Bank and USAID. Technical assistance in collecting biological specimens such as HIV test and anemia tests was provided by the Centre Pasteur du Cameroun (CPC) (Institut National de la Statistique & ICF International, 2012).

3.3 Benefits of DHS for this study

The wide breadth of data on individual and household level factors (available through DHS surveys) for many developing countries allow the investigation of a wide range of research questions. These data can be pooled to create larger sample sizes, used to compare outcome at different time points and the use of dyad/triad (groups of two or three respondents) approach to examine unique relationships. The DHS contains superior data because quality control measures of editing and verifying data simultaneously during data collection are used to minimize discrepancies. The use of multiple agencies, usually within each country, that provide personnel with expertise in specific aspects of the project ensure the high quality nature of the data. For instance, national statistical bureaus provide the sampling frames for national level studies, while the Ministry of Health provides trained health staff that collect survey biomarkers such as blood tests for anemia (DHS, n.d.-b). These maintain data accuracy while minimizing bias.

3.4 Data Preparation and Management

For this study, the Cameroon DHS (CDHS) from 2004 and 2011 were used. The samples for CDHS 1991 and 1998 were excluded because these surveys were conducted prior to the adoption of MDG 5. CDHS data of 2004 and 2011 were analyzed separately to estimate maternal mortality rates and ratios for the North and South and assess the determinants in Cameroon in 2004 and 2011. CDHS 2004 and 2011 were also pooled to create the final study sample to assess determinants of maternal mortality at the regional level in Cameroon.

The choice to pool data was primarily due to the nature of the outcome variable. When investigating rare health outcomes such as maternal mortality, a single cycle of CDHS may not provide the required sample size to detect valid associations between the outcome and independent variables at the regional level. For this study, it was necessary to increase power by

combining two cycles (2004 and 2011). This was feasible because of the standard nature of DHS datasets which are generally identical across surveys. Minor differences in the selected datasets were mostly in the wording of variable responses and the exclusion of some items in some survey cycles. These were expected to introduce minimal or no bias in the study because the variables retained the same information and the final variables selected for this study were available in both datasets.

Ethical consideration

Permission to use these data was granted by DHS Program after a study proposal was submitted; access to the data was provided by the DHS program. CDHS data is publicly available secondary data with non-identifiable information and does not need ethical clearance. Nonetheless, an ethics waiver was granted by the Research Ethics Board at Western University in accordance with regulations pertaining to the use of anonymous secondary data (Appendix 1).

3.5 Survey Design

3.5.1 Sampling frames

Enumeration Areas (EAs) of the Population and Housing Censuses of 2002/2003 and 2005, established by the Central Bureau of the Census and Population Studies (BUCREP) in Cameroon, were the sampling frames for the selected CDHS for 2004 and 2011 respectively. These EAs form the basic unit of a census and contain information about the area identifiers, type of place of residence (rural/urban), the number of households and a map of each EA. This structure allowed for sampling of survey participants using a multistage sampling methodology and the selection of persons in all 10 regions of Cameroon. For the purpose of these surveys, the main towns of Yaoundé and Douala were classified as separate regions due to their population size. Nomadic persons and individuals living in prisons were excluded.

3.5.2 Sampling design

Survey participants were selected through a two-stage sampling procedure. Firstly, the list of EAs provided by BUCREP was used to randomly select sample points (clusters). These selected points then served as the frame for the second stage of sampling. From these clusters, eligible households were identified. These households were selected from both urban and rural areas

(Institut National de la Statistique & ICF International, 2012; Institut National de la Statistique & ORC Macro, 2004b). Specific indicators at the national, and regional level, as well as urban and rural residency can therefore be assessed. Eligible participants were defined as individuals who were permanent residents or visitors who had spent the night at the selected household prior to the interview or survey.

The first stage of sampling design, probability proportional to size sampling method was used to systematically sample clusters or EAs according to their size. The second stage ensured equal probability of a household being selected from the selected clusters. In this, households in larger clusters had a smaller probability of being selected. A weight factor was added to the data to ensure results were proportional to the national level.

3.5.3 Questionnaire

The CDHS collect information on women, men and children at individual and household level using three questionnaires modeled after the standard MEASURE DHS program questionnaire. These were prepared in French and translated into English. Completion of questionnaires was contingent upon participants' consent at the start of interview. The household questionnaires captured household members and enabled the identification of women for the individual component of the survey. The women's questionnaire collected information from all women on background characteristics, reproductive history, family planning, maternal care and child health.

Some important health topics like female genital mutilation, domestic violence, and maternal mortality are not included in the standard DHS (core) questionnaire. This is because they may not be prominent in some of the countries where the DHS is administered or are difficult to measure. However, to ensure that these factors were assessed in countries of relevance, optional questionnaire modules were designed to capture these country specific needs. Maternal mortality, in particular, was made optional in the DHS due to difficulty collecting information on maternal death (The DHS Program, n.d.-b). In Cameroon, the optional maternal mortality module was included in the individual women questionnaire and information about maternal mortality was obtained from survey respondents.

3.5.4 Maternal mortality module

The focus of the maternal mortality module is sibling history and survival status using the direct sisterhood method to identify cases of maternal or pregnancy related deaths (Ahmed et al., 2014). The direct sisterhood method is a variant of the sisterhood method which obtains more detailed information about siblings compared to the more basic and cursory indirect sisterhood method. In it, female respondents are asked to list all siblings and their survival status at the time of interview. For each reported sibling, current age is collected. If sibling is deceased, year of death, and age at death are recorded. Deceased female siblings are further investigated to ascertain relationship between death and pregnancy for all sisters that died at age 12 or older. The direct sisterhood method relies on larger samples sizes, fewer assumptions and is advisably best used in settings of high fertility such as Cameroon (The DHS Program, n.d.-a).

3.6 Study design

This was a cross-sectional study that was conducted using secondary population-based, CDHS data for 2004 and 2011 to assess determinants of maternal mortality in women of childbearing age (15-49 years). Analysis was restricted to women (alive or deceased) who had given birth.

3.6.1 Basis for study design

No verbal autopsy was conducted in Cameroon to follow up on identified cases of maternal death in the CDHS. Hence, through the sibling history in the maternal mortality module, only age and parity for the deceased siblings were provided. Nevertheless, for this study, it was assumed that the deceased siblings were part of the same household as respondents and because of each other's social network would share similar characteristics with the respondents.

Indeed, social networks influence women's attitude and behavior (Gayen & Raeside, 2010). In Cameroon, women were more likely to use contraceptives if women in their network approved of and used contraceptives themselves (Valente, Watkins, Jato, Van Der Straten, & Tsitsol, 1997). Network partners' (women in their network) approval was strongly associated with the use of contraceptive methods in Cameroon. These network partners included female family members, and women of the same ethnic group.

The assumption that siblings are alike permits the attribution of select factors pertaining to the respondents to their deceased female sibling. These factors include ethnicity, religion, type of residence, educational level, wealth, type of contraception use, media exposure, distance to health facility, water quality, social autonomy, attitude towards domestic violence, and location.

3.7 Study Population

Participants in the DHS included a total of 26,082 (10,656 from 2004 and 15,426 from 2011) women of childbearing age 15-49 from all regions in Cameroon. This study looked at determinants of maternal mortality among these women. For this purpose, women who had been exposed to pregnancy and given birth to at least one child were the population of interest in which the outcome was assessed. These women consisted of study respondents and deceased siblings that were identified through the direct sisterhood method and had died of maternal related causes.

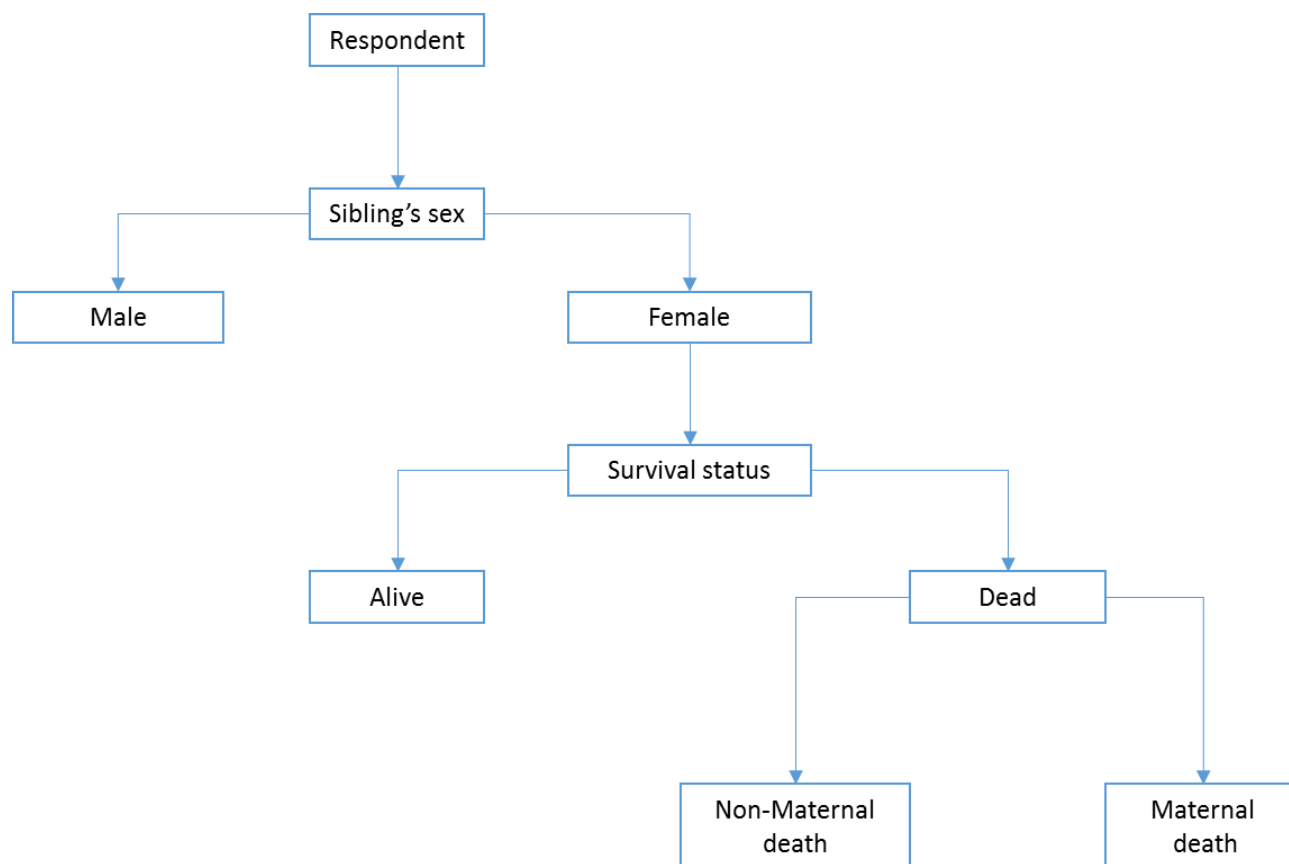
3.7.1 Respondents (living)

A respondent (living woman) was eligible for inclusion if she had at least one child. The following question in the CDHS was used for the identification of living women for this study: “Total children ever born?” To this question, they could respond by giving a number of total children ever born ranging from 0 to 20. Nulliparous women (women with 0 births) were thus, excluded.

3.7.2 Deceased women (respondents’ siblings)

The maternal mortality module was used to identify women who died from maternal related causes. Respondents were asked about the survival status of siblings born to the same mother as them with these questions: “Is (name) male or female?” The possible responses to this question were: “male, female, don’t know”; “Is (name) still alive?” to which they could respond: “dead, alive, don’t know”. “Sibling’s death and pregnancy” had the following categories: “never pregnant, death not related, died while pregnant, died during delivery, since delivery, 6 weeks after delivery, 2 months after delivery, and don’t know”.

Figure 6: Flowchart for the Identification of Female Sibling Who Died of Maternal Related Causes



3.8 Description of Measures

This section reviews key variables identified in the CDHS surveys of 2004 and 2011 utilized in this thesis. Variables were extracted and reconstructed to suit the purpose of this study (see Appendix 4). The main outcome variable was maternal mortality and all other variables were independent variables.

Table 1: Variables Selected for Living Women and Deceased Female Siblings

	Deceased female siblings	Living women
Individual level	Age ¹	Age
	Parity ¹	Parity
	Social autonomy ²	Social autonomy
	Domestic violence ²	Domestic violence
	Distance to facility ²	Distance to facility
	Media exposure ²	Media exposure
	Contraception type ²	Contraception type
	Education ²	Education
	Religion ²	Religion
	Ethnicity ²	Ethnicity
	Type of residence ²	Type of residence
	Wealth index ²	Wealth index
	Water quality ²	Water quality
	Region ²	Region
	Survival status ¹	Survival status
Community level	Education	Education
	Wealth index	Wealth index

1= questions asked of respondents about deceased female sibling

2= information ascribed to deceased female sibling based on respondents' characteristics

3.8.1 Outcome variable

Maternal mortality

Maternal mortality was the outcome for this study which is defined as the death of a woman during pregnancy, childbirth or within 42 days after delivery or termination of pregnancy.

Information on maternal mortality is collected using the module on maternal mortality which is included in the women's questionnaire at the time of the interview and combined with the women's data in one final data file. In the CDHS, respondents were asked whether female sibling died while pregnant, during child birth, or within 6 weeks or 2 months of delivery. Respondents could indicate yes, no or don't know. These questions were combined in the CDHS as "sibling's death and pregnancy" with the same response categories.

For this study, a separate sibling file was created to identify siblings that died of maternal related causes before appending the file to that of the respondents. First, the data was reshaped from

wide to long data using the respondent identifier, and the maternal mortality index variable. This permits the deceased siblings to become their own observations in the new file. All other siblings were dropped from the file if they were alive, male, or missing. A new variable was then created for survival status (maternal outcome) to identify deceased siblings. The values of this new variable were replaced with the response categories from the CDHS variable for mortality. This new variable was then recoded where 0 was for non-maternal death (never pregnant, death not related, 2 months after delivery, and don't know), 1 for respondent (has a deceased sibling from maternal mortality) and 2, was for maternal death (died while pregnant, died during delivery, since delivery, and 6 weeks after deliver).

All non-maternal deaths were then excluded. This sibling (selected deceased female) file was then appended to the respondent file. Respondents who had a sibling die of maternal related causes and whose information were ascribed to the deceased sibling were then excluded from the final sample using the survival status variable for which they were coded as 1 (has a deceased sibling from maternal mortality). In the final sample, respondents who had missing information (because they had no sibling die from maternal mortality) for survival status variable for maternal mortality, they were assigned a value of 0 which identified them as for alive. The final survival status therefore had 0 for alive and 2 for deceased. For this study, this variable was coded as 0 for alive and 1 for maternal death.

3.8.2 Independent Variables

Age

In the CDHS, age was collected by asking respondents “in what month and year were you born?” Also, for deceased female siblings, respondents were asked these questions “what is (name) age?” and “what was (name) age at death?” In this study, the age was retained as a continuous variable.

Parity

Parity was assessed in the CDHS with the question “Total children ever born” to which responses could range from 1 to 20 children. For deceased female siblings, respondents were asked, “number of sibling's children” to which responses could range from 1 to 24. These two

variables each identified respondents and deceased siblings. The variable for parity was a continuous variable.

Distance to facility

For distance to health facility, respondents were asked “The distance to the health facility?” The response options were, “no problem”, “not a big problem” and “big problem”. In CDHS 2011, the question on distance to health facility was asked of a subsample of women. This is because this question was included in a section of the questionnaire that had a skip pattern that excluded about 50% of the initial number of respondents. This question was asked in every other household that was selected. However, this exclusion was not because of non-applicability or non-response. Hence, the respondents in the final study sample who had missing values for this question were assigned a response option of unknown. The response options for distance to health facility were thereby recoded as “no problem”, “small problem”, “big problem”, and “unknown”.

Media exposure

Media exposure was measured through assessing respondents’ exposure frequency to listening to the radio, watching television, and reading a newspaper or magazine. These were assessed with the following questions: “Do you read a newspaper or magazine, at least once a week, less than once a week or not at all?”, “Do you listen to the radio, at least once a week, less than once a week or not at all?”, and “Do you watch television, at least once a week, less than once a week or not at all?” The response options were “0=not at all”, “1=less than once a week”, “2=at least once a week”, and “3=almost every day”. A composite measure was then constructed from the three measures of media exposure. The response values for this composite measure of media exposure ranged from 0 to 9 where 0 was “not at all” on all three forms of media and a score of 9 being “almost every day” response on all 3 media forms. They were categorized as no exposure (0), low exposure (1-3), medium exposure (4-6), and high exposure (7-9).

Current contraceptive type

The type of contraceptives being used was assessed with this question in CDHS: “Which method are you using?” to which the respondent could respond by mentioning the type of contraceptive

being used (such as female sterilization, IUD, injectable, implants, pills, condoms, lactation method and more). These were recoded in the CDHS as “no method”, “folkloric method”, “traditional method”, and “modern method”. For the purpose of this study, these response options were recoded into “no method”, “folk/traditional”, and “modern”.

Social autonomy

Social autonomy was assessed in the CDHS through women’s participation in decision making using four measures that examined a woman’s involvement in her own health care, household, and family/relatives visits. For each of these four dimensions of decision-making, the DHS questionnaire asked married women: “Who usually makes decisions about health care for yourself?”, “Who usually makes decisions about making major household purchases?”, “Who usually makes decision about daily household purchases?”, and “Who usually makes decisions about visits to your family or relatives?” Each question had five response options: “respondent alone”, “respondent and husband/partner”, “husband/partner alone”, “someone else”, and “others”.

In this study, these response options were recoded to a binary form: Participation in decision making was coded as 1 and coded as 0 for no participation in decision making. A composite measure was then constructed with the four individual measures for autonomy. The values for this composite measure ranged from 0 to 4, where 0 was no participation and 4 was for a woman who participated in decision making in all four individual measures.

Domestic violence

Women’s attitude towards husband/partner beating wife in select circumstances was used to assess domestic violence. Respondents were asked in the CDHS, “In your opinion, is a husband justified in hitting or beating his wife in the following situations?” These were the situations presented to respondents in the CDHS: “If she goes out without telling him”, “If she neglects the children”, “If she argues with him”, and “If she refuses to have sex with him”. To these, response options were, “yes”, “no”, “don’t know”. For this study, these response options were recoded 0 for “no” and 1 for “yes/don’t know”. A composite measure was then constructed with the four individual measures of domestic violence. For this, the response options were a sum of the

individual scores ranging from 0 to 4. A score of 0 meant a woman did not approve of violence in any of the situations and a score of 4 was approval of violence in all four situations.

Education

CDHS assessed respondents' exposure to education and highest level of education completed with these questions: "Have you ever attended school?" and "What is the highest level of school you attended?" Women who identified as having attended school with the first CDHS question were then asked the second question where they could respond "primary", "secondary" or "higher". The final CDHS measure for highest level of education then consisted of these categories "no education", "primary", "secondary" and "higher". For this study, the response options were further recoded to "no education", "primary", or "secondary/higher".

Religion

In the CDHS, respondents' religion was examined with the question "what is your religion?" The response options included "Catholic", "Protestant", "Moslem", "animist", "other Christian", "none" and "other". In CDHS 2004, the response categories above were used including an extra category for "new religions". In this study, these responses were recoded in this study as "Catholics", "other Christians", "Moslems" and "Animist/none/other".

Ethnicity

CDHS measured ethnicity by asking the respondents "what is your ethnicity?" Ethnicity reported was noted. For this study, ethnicity was recoded to capture the main ethnic groups in the Cameroon (see appendix 2). These categories were "arab-choa/peulh/haoussa/kanuri", "biu-mandara", "adamaoua-oubangui", "bantoïde south-west/grassfields", "bamilike/bamoun/côtier/ngoe/oroko", "beti/bassa/mbam/kako/meke/pygmé", and stranger/other". Given the connection between region and ethnicity in Cameroon, two new ethnicity variables were constructed to capture the main ethnic groups in the North and South regions. The new ethnicity variables were "North ethnicity" was for the North and "South ethnicity" for the South.

Type of residence

In the CDHS, type of place of residence for the respondents was categorized as “urban” and “rural” depending on the location where the women were interviewed and the category that was assigned from the enumerated areas of the sampling frame.

Wealth index

Wealth index was a measure of economic status where an asset score was derived by the CDHS using principal component analysis and assigned to the respondents. This single score represents the assessment of individual assets such as ownership of a television, radio, material used for housing construction, and other amenities that reflect an individual’s standard of living. This single score of weighted sums of household assets was then categorized into five quintiles of wealth by the CDHS as: poorest, poorer, middle, richer, richest. This is a standardized and accepted method of measuring wealth (Howe, Hargreaves, & Huttly, 2008; The DHS Program, n.d.-c; Vyas & Kumaranayake, 2006). For this study, wealth index was recoded into three categories. The poorest and poorer quintiles were recoded as “poor”, and the richer and richest quintiles were coded as “rich”. The final response options used for this study were “poor”, “middle” and “rich”.

Water quality

For the measurement of water quality, CDHS asked respondents “What is the main source of drinking water for members of your household?” (See Appendix 5 for response options CDHS 2004 and 2011). Response options included several sources of water. For this study, two main categories were constructed under which the response options were recoded: “improved” and “unimproved”. Improved drinking water source is water protected from outside contamination by its natural construction or a deliberate intervention (WHO/UNICEF, 2008). This includes piped water, public tap, tube well, protected dug well, protected spring and rainwater while unimproved drinking water sources includes unprotected dug well, unprotected spring, tanker truck, surface water and bottled water.

Region

The 10 administrative regions of Cameroon and the cities of Yaoundé and Douala were recorded as 12 regions in the CDHS. A new variable for region was created in this study which grouped the three northern regions (North, Far North and Adamawa) as “North”. The remaining 7 regions

(north west, southwest, center, south, east and west) along with the cities of Douala and Yaoundé were grouped together to create the “South”.

Community level education and wealth

In this study, education and wealth were explored at the community level. To achieve this, community was defined at the regional level. An aggregate of individual responses was used to construct regional level education and wealth. For education, individuals with no education or with primary education were assigned a value of 0. Those who had secondary or higher education were assigned a value of 1. A new variable was then generated where the mean value was assigned to all individuals according to their region. This mean value represented the proportion of individuals with secondary or higher education in each region. Likewise, for community wealth, a value of 0 was assigned to individuals whose individual wealth index was poor or middle and those who were rich were coded as 1. The means of these values were also then assigned to individuals in the respective regions.

Missing data

Variables in this study such as age, contraception type, wealth index, type of residence, region, and education had 0% missingness. Parity, domestic violence, media exposure variables had missingness below 1.5%. The water quality variable had missingness of 4.7%. Social autonomy and distance to facility had missingness at 11.9% and 30.9% respectively. Imputation procedures were performed to reduce the proportion of missingness. For social autonomy, a mean value, derived from a set of observed values in the dataset (closest predicted mean), was imputed (predictive mean matching imputation) (Little, 1988). This method matches the missing value to the observed value with the closest predicted mean (nearest neighbor). The category of “unknown” was assigned to individuals with missing values for distance to facility. Non de jure residents (people who do not usually live in the surveyed household) were coded as missing for the measure of water quality since this question assessed water quality for the selected household and not their rightful residence.

Table 2: Number of Missing Values for Variables After Pooled Surveys (n=18,665)

Variable	Number of missing	Reason for missing	Action
Age	0		
Parity	1		None
Social autonomy	2227 (11.93%)	Asked from women in union only	- Full autonomy ascribed to women who were head of household and are alive (n=734) - univariate multiple imputation method: predictive mean matching for all other missing (n=1,493)
Domestic violence	69		None
Distance to facility	5764 (30.88%)	Male sample skip pattern questionnaire. Every other house was skipped	All women who had no response for this item were coded as unknown
Media exposure	7		None
Contraception type	0		
Education	0		
Religion	45		None
Ethnicity	59		None
Type of residence	0		
Wealth index	0		
Water quality	884 (4.74%)	Non de jure residents These respondents were not in the rightful place of residence	Non de jure residents were coded as missing
Region	0		
Survival status	0		

3.9 Statistical analyses

All statistical analyses were performed using Stata SE13 (StataCorp, 2013). Descriptive statistics were computed, bivariate analyses were performed to assess the relationship between the independent variables and the outcome variable. Maternal mortality rates and ratios were computed for each region (North and South). Multivariable analyses were performed to assess the association of each independent variable with the outcome variable while controlling for the other independent variables.

3.9.1 Survey data adjustments

CDHS is complex survey data that may introduce bias through oversampled subpopulations if unequal weights, non-responsiveness, stratification and clustering are not adjusted for. The use of survey sampling weights allowed for adjustments for these issues to ensure stable estimates and standard errors. Also, strata with 1 sampling unit were centered at the grand mean and not stratum mean.

3.9.2 Objective I: maternal mortality ratio and rate

The first objective was to estimate maternal mortality (MM) rate/ratios for the North and South regions of Cameroon in 2004 and 2011. Maternal mortality rate estimates the risk of maternal mortality to a woman of reproductive age (15-49 years of age). This measure reflects the extent of maternal death as a cause of death among women (cause-specific death rate). Maternal mortality ratio is the number of maternal deaths per 100,000 live births. It expresses the risk of maternal death according to the frequency of childbearing (Ahmed et al., 2014).

An important measure that is needed for the calculation of maternal mortality ratio is the General Fertility Rate (GFR). GFR is the average number of children currently being born to women of reproductive age (Rutstein & Rojas, 2006). It is also the link between maternal mortality rate and ratio.

For the calculation of MM rates and ratios, the reference period was set to seven years. This reference period enables the calculation of the number of woman person years of exposure to the risk of maternal mortality, and the estimation of the number of maternal deaths occurring during that time.

Firstly, MM rate was obtained by calculating the sample weighted number of maternal deaths for each age group in the North and South. The total weighted number of death was the numerator for the MM Rate. Next, exposure was computed by calculating the upper and lower limit of inclusion in the reference time period. Exposure time (person years) was then calculated for the youngest, middle and oldest age groups in the sample. Exposure time was then computed for each age group. The number of woman person-years is the sum of the number of years exposed in the five-year age groups during the specified time period.

The MM rate was then computed with the formula below.

$$\frac{\text{number of maternal deaths}}{\text{number of woman person-years}} \times 1000 = \text{MMRate}$$

Once the MM rate was obtained, the general fertility rate (GFR), (which is the average number of children currently being born to women of reproductive age), was calculated. The period length was set at seven years and maximum age set at 44 years. Age-specific fertility rates for each of the 5-year age group of women for the seven year period were calculated. The age-specific rates were then summed to get the total fertility rates (total number of births for specified period). The sum of all births for the seven year period (total number of births in 7 years) was the numerator and the total number of women-years of exposure during that period was the denominator. This calculation was performed and GFR was obtained. With the GFR, the MM ratio was calculated using the formula below.

$$\frac{\text{MMRate}}{\text{GFR}} = \text{MMRatio}$$

3.9.3 Objective II:

To determine whether the North and South of Cameroon differ in terms of determinants of maternal mortality.

Univariate Analyses

Univariate analyses were performed to allow an understanding of the nature of the data. Means and standard deviations (SD) were used to describe continuous variables (age, parity, domestic violence, community wealth, and community education). For the mean value of social autonomy, SD could not be computed because the mean obtained was a grand mean for which standard error (SE) was obtained. Proportions were calculated for categorical variables such as age group, distance to facility, media exposure, contraception type, education, religion, ethnicity, type of residence, wealth index, water source quality, and region. Univariate analyses were performed for the whole sample, and for the sample divided by the separate regions (North and South) of Cameroon.

Bivariate Analyses

Bivariate analyses were performed to assess associations between maternal mortality outcome variable and each independent variable. Simple logistic regressions were performed to assess the crude association between each independent variable and the outcome variable for the whole sample, by the survey years 2004 and 2011, and for the North and South regions. The significance of these tests was set at $p < 0.05$.

Multivariable analyses

The second objective of this study was to determine whether the North and South of Cameroon differed in terms of determinants of maternal mortality. Survey adjusted multivariable logistic regression analyses were used to investigate the association of the independent variables and the outcome of maternal mortality while controlling for other variables. The analysis steps were organized by research questions.

Question 2: *What determinants influence maternal mortality in Cameroon?*

Logistic regressions were run to investigate the association between the outcome and the independent variables in Cameroon.

Question 3: *Did determinants of maternal mortality change between 2004 and 2011 in Cameroon?*

Logistic regressions were run for each survey year (2004 and 2011).

Question 4: *Do the women of the North and South regions differ on the determinants of maternal mortality in Cameroon?*

Two separate multivariable logistic regression models were run for each region to assess differences between the North and South.

Statistical significance:

Statistical significance for all regressions performed was determined at $p < 0.05$. The estimates obtained were odds ratios.

Chapter 4: Results

4 Study findings

This study estimated the levels of maternal mortality in the North and South Cameroon. The associations between the independent variables and maternal mortality in Cameroon were examined, with the aim of answering three specific questions noted in Chapters 2 and 3. This chapter presents an overview of the sample characteristics and the results of the bivariate and multivariable analyses.

4.1 Description of surveys

For survey year 2011, the CDHS randomly selected 580 clusters that included 291 urban and 289 rural clusters. From these, about 24 and 28 households were selected from each urban and rural area respectively, resulting in the selection of a total of 15,050 households that were eligible for survey. A total of 15,852 eligible women were identified and 15,426 of them were interviewed. There were 7,525 eligible men and 7,191 were interviewed. The response rate for eligible women was 97.3% (Institut National de la Statistique & ICF International, 2012).

Likewise, 466 clusters were randomly selected and about 22 and 28 households were selected from urban and rural areas respectively by the CDHS in 2004. There were 222 rural and 244 urban clusters. A total of 11,556 households were eligible and 10,462 were surveyed. The surveyed household constituted the final sample of 10,656 women age 15-49, and 5,280 men age 15-59. The response rate for eligible women was 94.3% (Institut National de la Statistique & ORC Macro, 2004b).

4.2 Descriptive analysis

4.2.1 Distribution of the dependent variable: maternal mortality

CDHS data 2004 and 2011 were pooled; the final sample consisted of 18,665 women (living and deceased). 18,094 (96.9%) of these women were living or alive at the time of the interview. 571 (3.1%) were women who had died while pregnant, at childbirth or within 6 weeks of delivery. Looking at the individual survey years, 204 (35.7%) maternal deaths were reported in 2004 for the period 1998 – 2004. In 2011, there were 367 (64.3%) maternal deaths for the period 2004 –

2011. 62.5% of all maternal deaths were reported in the South region. 13,055 (69.9%) of the sample were located in the South region of Cameroon and 5,610 (30.1%) of the women resided in the North.

The maternal mortality rates/ratios calculated using the CDHS 2004 and 2011 are shown in figures 7 and 8. On the national scale, the maternal mortality rate and ratio in Cameroon are rising. Maternal mortality rates and ratios were computed for the North and South regions of Cameroon. Compared to Cameroon as a whole, the North and South had rates and ratios similar to those reported for Cameroon in 2004. However, there was a rise in the maternal mortality rate and ratio for the North region in 2011. These values were almost twice as high as the rate and ratio for the entire country.

Figure 7: Maternal Mortality Rate in the North and South Regions and Cameroon Overall in 2004 & 2011

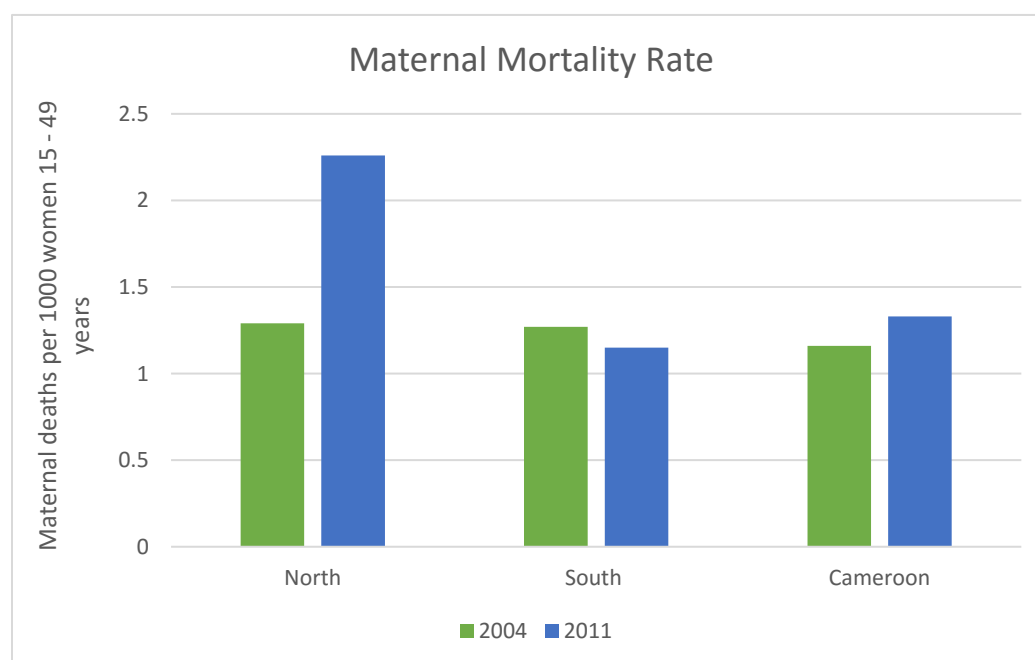
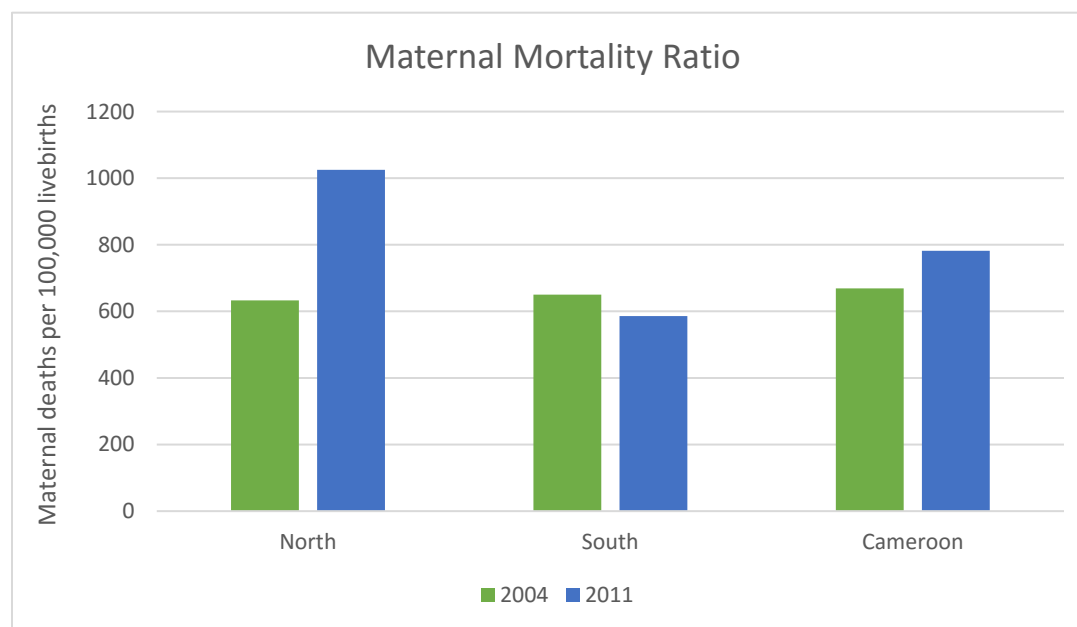


Figure 8: Maternal Mortality Ratio in the North and South Regions and Cameroon Overall in 2004 & 2011



4.2.2 Distribution of variables:

This section describes the study sample and presents the distribution of women by the independent variables according to their survival status in the pooled sample (CDHS 2004 and 2011), in the North (2004 and 2011 pooled), and in the South (2004 and 2011 pooled). Table 3 shows the sample characteristics.

Overall pooled (CDHS 2004 and 2011)

The overall study sample consisted of 18,665 (18,094 living and 571 deceased) women of childbearing age. The mean age was 30.8 years with a majority of women in the 20-24 and 25–29 years age groups. The average number of children was 3.83. The mean scores for social autonomy and domestic violence were 2.04 and 1.20 (range: 0 - 4) respectively. Whether women had a problem with distance to health facility was unknown for about 30% of women while 27.8% had a big problem with distance to health facility.

Also, the majority (65.8%) of women had low or no media exposure; most (74.4%) did not use any method of contraceptives, and had a primary level education (41.8%). Catholics and other Christians constituted the main religious groups. The largest ethnic group was Beti/Bassa

/Mbam/Kako/Meka/Pygmé (26.7%) closely followed by the Bamileke/Bamoun/ Cotier/ Ngoe/Oroko group. Almost half of the women lived in urban (45.1%) and rural (54.9%) areas of the country. An equal proportion of women (39%) in Cameroon belonged to the rich and poor category and had improved water (60.8%).

North (2004 and 2011 pooled)

There was a total of 5,610 women in the North with a mean age of 30 (range: 15-49) years and a majority of women in the 20-24 and 25–29 years age groups. The average number of children born was 4.4. Mean scores for social autonomy were 1.42 (range: 0 - 4), and domestic violence 1.38 (range: 0 - 4) in the North differed from the national pooled averages

A majority of women had a big problem with distance (33.2%) and had no education (67.2%). Muslims were the majority (47.6%) in the North and the dominant ethnic groups were Biu-Mandara and Adamawa-Oubangui. Only 28.5% of deceased women resided in urban areas while the majority (71.5%) lived in rural areas. The bulk of women were poor (66.88%) and had unimproved water (53.8%).

South (2004 and 2011 pooled)

There was a total of 13,055 women in the South where the average age was 31.2 years. Similar to the North, most women were in the 20-24 and 25–29 years age groups. The average number of children born to a woman in the South was 3.5 and the mean score for domestic violence was 1.13 (range: 0-4). Distance to health facility was no problem for 26.4% of women in the South. Like the North, contraceptive use was low with 66.1% of women reporting no method of contraceptives in the South. Most women (94%) had at least a primary or secondary/higher level education.

Unlike the North, Catholics were the dominant religious group in the South while Beti/Bassa/ Mbam/ Kako/Meka/Pygmé (37.7%) and Bamileke/Bamoun/Cotier/ Ngoe/Oroko (34.8%) were the main ethnic groups in this region. Over half of women lived in urban areas with a majority of women (49.1%) in the rich tertile and 67.2% of women had improved water.

Table 3: Characteristics of Women - Overall, in the North and South (pooled)

Variable	Overall (n=18,665)	North (n=5,610)	South (n=13,055)
	N (%)	N (%)	N (%)
Survival status			
Alive	18,094 (96.9)	5,396 (96.2)	12,698 (97.3)
Dead	571 (3.1)	214 (3.8)	357 (2.73)
	Mean (SD)	Mean (SD)	Mean (SD)
Community level			
Community education (range: 0-1)	0.35 (0.47)	0.07 (0.26)	0.47 (0.5)
Community wealth (range: 0-1)	0.39 (0.5)	0.16 (0.36)	0.49 (0.5)
Individual level			
Age (range: 15-49)	30.8 (8.8)	30.0 (8.7)	31.2 (8.8)
Parity (range: 0-20)	3.78 (2.6)	4.4 (2.9)	3.5 (2.4)
Social autonomy (range: 0-4)	2.04 (SE 0.02)	1.42 (SE 0.05)	2.35 (SE 0.02)
Domestic violence (range: 0-4)	1.20 (1.40)	1.38 (1.57)	1.13 (1.31)
Categorical variables	N (%)	N (%)	N (%)
Distance to facility			
No Problem	4,507 (24.15)	1,055 (18.81)	3,452 (26.44)
small problem	3,205 (17.17)	929 (16.56)	2,276 (17.43)
Big problem	5,189 (27.8)	1,864 (33.2)	3,325 (25.5)
unknown	5,764 (30.9)	1,762 (31.4)	4,002 (30.7)
Media exposure			
No exposure	5,631 (30.2)	3,133 (55.9)	2,498 (19.1)
Low exposure	6,641 (35.6)	1,707 (30.4)	4,934 (37.8)
Medium exposure	4,823 (25.9)	627 (11.2)	4,196 (32.2)
High exposure	1,563 (8.4)	140 (2.5)	1,423 (10.9)
Contraception type			
No method	13,878 (74.4)	5,252 (93.7)	8,624 (66.1)
Folk/traditional	2,091 (11.2)	90 (1.6)	2,001 (15.3)
Modern	2,696 (14.4)	266 (4.7)	2,430 (18.6)
Education			
No education	4,342 (23.3)	3,609 (64.3)	733 (5.6)
Primary	7,794 (41.8)	1,606 (28.6)	6,188 (47.4)
Secondary/higher	6,529 (34.9)	395 (7.0)	6,134 (46.9)
Religion			
Catholics	6,800 (36.5)	1,018 (18.2)	5,782 (44.4)
Other Christians	6,819 (36.6)	1,236 (22.1)	5,583 (42.8)
Muslims	3,371 (19.2)	2,662 (47.6)	1,009 (7.7)
Animist/None/Other	1,330 (7.1)	673 (12.0)	657 (5.0)
Ethnicity			
arab-choa/peulh/haoussa/kanuri	1,740 (9.4)	1,477 (26.4)	263 (2.0)
biu-mandara	1,961 (10.5)	1,892 (33.8)	69 (0.5)
adamaoua-oubangui	2,138 (11.5)	1,803 (32.2)	335 (2.6)
bantoide south-west/grassfields	2,603 (13.9)	47 (0.8)	2,556 (19.6)
bamilike/bamoun/côtier/ngoe/oroko	4,591 (24.7)	80 (1.4)	4,511 (34.8)
beti/bassa/mbam/kako/meke/pygmé	4,972 (26.7)	72 (1.3)	4,900 (37.7)
stranger/other	601 (3.2)	224 (4.0)	377 (2.9)
Type of residence			
Urban	8,426 (45.1)	1,601 (28.5)	6,825 (52.3)
Rural	10,239 (54.9)	4,009 (71.5)	6,230 (47.7)
Wealth index			
Poor	7,285 (39.0)	3,769 (67.2)	3,516 (26.9)
Middle	4,099 (21.9)	972 (17.3)	3,127 (23.9)
Rich	7,281 (39.0)	869 (15.49)	6,412 (49.1)
Water quality			
Improved	10,807 (60.8)	2,524 (46.2)	8,283 (67.2)
Unimproved	6,974 (39.3)	2,939 (53.8)	4,035 (32.8)

See Table 4 characteristics of deceased women

Deceased women: Pooled (CDHS 2004 and 2011)

There were 571 deceased women in this study. The mean age was 26.2 years and the average number of children born was 2.25 children. The mean score for domestic violence was 1.35 (range: 1 - 4). Distance to health facility was not a problem for 20.8%, while for about 29.6%, it was a big problem. The majority of deceased women had a primary education (41.7%), were Catholic (36.1%), lived in rural areas (62.7%), and were poor (47.1%).

Deceased women: North (pooled)

In the North, there were 214 deceased women. The mean age was 24.9 years. Deceased women were mostly in the 15-19 and 20-24 years age groups in the North. The mean score for domestic violence was 1.26 (range: 0 - 4) which is lower than the overall sample average. More deceased women (33.6%) had a big problem with distance to health facility, while 11.7% had no problem. Of all deceased women only 4.2% had a secondary or higher education. The majority of these women were Muslims, from the Bui-mandara ethnic group and lived in rural areas. Most deceased women were poor (74.8%) and had unimproved water (59.6%).

Deceased women: South

There were 357 deceased women from the South with a mean age of 27 years. Most of them were between 20 and 34 years of age. Deceased women from this region had a higher domestic violence mean score 1.40 (range: 0 - 4) compared to the North and the overall sample. There were more deceased women who had a secondary or higher education (40.6%) and primary education (53.5%). The majority of deceased women were Catholics or other Christians, were from the Beti/bassa/mbam/kako/meke/pygmé ethnic group and were rich.

Table 4: Characteristics of Deceased Women - Overall, in the North and South (pooled)

Variable	Overall (n=571)	North (n=214)	South (n=357)
	Mean (SD)	Mean (SD)	Mean (SD)
Community level			
Community education (range:0-1)	0.32 (0.23)	0.06 (0.04)	0.48 (0.15)
Community wealth (range:0-1)	0.35 (0.25)	0.14 (0.08)	0.48 (0.24)
Individual level			
Age (range:15-49)	26.23 (7.51)	24.94 (7.73)	27.00 (7.28)
Parity (range:0-20)	2.25 (2.30)	2.37 (2.29)	2.18 (2.31)
Social autonomy (range:0-4)	1.93 (1.94) [1.56 (SE=0.09)]	1.46 (1.47) [1.58 (SE=0.12)]	2.24 (2.28) [1.48 (SE=0.11)]
Domestic violence (range:0-4)	1.35 (1.48)	1.26 (1.54)	1.40 (1.44)
	N (%)	N (%)	N (%)
Distance to facility			
No problem	119 (20.8)	25 (11.7)	94 (26.3)
Small problem	84 (14.7)	32 (14.9)	52 (14.6)
Big problem	169 (29.6)	72 (33.6)	97 (27.2)
unknown	199 (34.9)	85 (39.7)	114 (31.9)
Media exposure			
No exposure	199 (34.9)	133 (62.2)	66 (18.5)
Low exposure	193 (33.8)	61 (28.5)	132 (36.9)
Medium exposure	137 (23.9)	17 (7.9)	120 (33.6)
High exposure	42 (7.4)	3 (1.4)	39 (10.9)
Contraception type			
No method	442 (77.4)	203 (94.9)	239 (66.9)
Folk/traditional	55 (9.6)	5 (2.3)	50 (14.0)
Modern	74 (12.9)	6 (2.8)	68 (19.1)
Education			
No education	179 (31.4)	158 (73.8)	21 (5.9)
Primary	238 (41.7)	47 (21.9)	191 (53.5)
Secondary/higher	154 (26.9)	9 (4.2)	145 (40.6)
Religion			
Catholics	206 (36.1)	46 (21.6)	160 (44.8)
Other Christians	203 (35.6)	45 (21.1)	158 (44.3)
Muslims	119 (20.9)	91 (42.7)	28 (7.8)
Animist/None/Other	42 (7.4)	31 (14.6)	11 (3.1)
Ethnicity			
arab-choa/peulh/haoussa/kanuri	63 (11.0)	52 (24.3)	--
biu-mandara	79 (13.8)	77 (35.9)	--
adamaoua-oubangui	80 (14.0)	71 (33.2)	--
bantoïde south-west/grassfields	62 (10.9)	--	59 (16.5)
bamilike/bamoun/côtier/ngoe/oroko	90 (15.8)	--	90 (25.2)
beti/bassa/mbam/kako/meke/pygmé	175 (30.7)	--	174 (48.7)
stranger/other	22 (3.9)	14 (6.5)	34 (9.5)
Type of residence			
Urban	213 (37.3)	51 (23.8)	162 (45.4)
Rural	358 (62.7)	163 (76.2)	195 (54.6)
Wealth index			
Poor	269 (47.1)	160 (74.8)	109 (30.5)
Middle	132 (23.1)	33 (15.4)	99 (27.7)
Rich	170 (29.8)	21 (9.8)	149 (41.7)
Water quality			
Improved	300 (55.1)	84 (40.4)	216 (64.1)
Unimproved	245 (44.9)	124 (59.6)	121 (35.9)
Region			
North	214 (37.5)	--	--
South	357 (62.5)		

4.3 Bivariate analyses

The distribution of maternal mortality was examined for each independent variable. This was done for the overall pooled sample, the CDHS 2004 and 2011, and for the North (pooled) and South (pooled). The findings these analyses are reported on Table 5.

Overall pooled (CDHS 2004 and 2011)

Community wealth (OR 0.49, 95% CI: 0.33 - 0.73) and community education (OR 0.46, 95% CI: 0.30 – 0.70) were significantly associated with maternal mortality. The odds of maternal death decreased with an increase in community wealth or community education. Age was significantly associated with mortality where the odds of maternal death decreased with age. Like age, parity had a negative association with death (decreasing odds of maternal death). Media exposure was significantly associated with maternal mortality, with decreasing odds of maternal death for all categories of exposure (low exposure, medium exposure, and high exposure), when compared to women with no media exposure. Education had a significant association with maternal mortality with the odds of maternal death decreasing with an increasing level of education. A significant association between ethnicity and maternal mortality was also seen. The odds of death were reduced among women of the Bantoide South-west/Grassfields (OR 0.65, 95% CI: 0.45 – 0.95) and the Bamileke/Bamoun/ Cotier/Ngoe/Oroko ethnic groups (OR 0.56, 95% CI: 0.39 – 0.80) compared to Arab-choa/Peulh/Haoussa/Kanuri women.

A rural residence was associated with maternal mortality, where women who resided in rural areas had a 42% increased odds of maternal mortality compared to women in urban areas. Rich women on the other hand had 39% reduction in odds of maternal death compared to poor women. Water quality was associated with maternal mortality. Compared to women with improved water, the odds of maternal mortality were significantly higher (by 27%) for women with unimproved water. Social autonomy, domestic violence, distance, contraception type, and religion were not significant in the overall sample.

CDHS 2004

Age and parity were both significantly associated with maternal mortality. The odds of maternal mortality were reduced by 7% and 27% respectively with increasing age and parity. Being of the Bantoide-Southwest/Grassfield ethnic group was protective of maternal mortality compared to

women from the Arab-Choa/Peulh/Haoussa/Kanuri ethnic group, having a reduced odds (OR 0.73, 95% CI: 0.37 – 1.44) of maternal mortality.

For CDHS 2004, community wealth, community education, social autonomy, domestic violence, distance to facility, media exposure, contraception type, education, religion, type of residence, wealth index and water quality were not significantly associated with maternal mortality

CDHS 2011

Age and parity were associated with maternal death; increasing age and parity had a negative association with death (decreasing odds of maternal death). When compared to those who reported having no problem of distance to health facility, distance was associated with mortality in women who reported a big problem with distance. Media exposure was significantly associated with maternal mortality when compared to women who had no media exposure. There was a protective association between contraceptive use and maternal mortality. Women who used folkloric/traditional method of contraception had a decreased odds (OR 0.61, 95% CI: 0.38 – 0.98) of maternal mortality compared to women who used no method of contraception. Increasing units of domestic violence (attitude towards wife beating by husband/partner) significantly increased odds (by 13%) of maternal death.

Education was protective of maternal mortality with reduction in odds of maternal death with increasing levels of education (primary, secondary/higher) compared with having no education. Also, women from the Bantoide South-west/Grassfields (OR 0.62, 95% CI: 0.40 – 0.98) and the Bamileke/Bamoun/Cotier/Ngoe/Oroko ethnic groups (OR 0.56, 95% CI: 0.35 – 0.88) had reduced odds of maternal mortality compared to those from the Arab-Choa/Peulh/Haoussa/ Kanuri ethnic group. Compared to women in urban areas, women living in rural areas had a 60% increase in odds of maternal mortality. Women with unimproved water, had increased odds of maternal death (OR 1.46, 95% CI: 1.12 – 1.92) compared to those with improved water quality. Wealth was associated with maternal mortality where rich women, compared to poor women, had a 50% reduced odds of maternal mortality. Community wealth and community education were negatively associated with maternal mortality. Religion was not associated with maternal mortality.

North (2004 and 2011 pooled)

In the North, age (OR 0.92, 95% CI: 0.89 – 0.94) and parity (OR 0.69, 95% CI: 0.63 – 0.77) were negatively associated with maternal mortality. There was an association with distance to facility and maternal mortality where women who had a big problem with distance to health facility (OR 1.88, 95% CI: 1.16 – 3.05) had an increased odds of maternal mortality compared to women with no problem. There was a protective association between education and maternal mortality. Women with a primary education had a 37% reduction in odds of maternal death compared to those with no education. Community wealth and community education were negatively associated with maternal mortality. In the North, social autonomy, domestic violence, media exposure, contraception type, religion, ethnicity, type of residence, wealth index, and water season were not associated with maternal mortality.

South (2004 and 2011 pooled)

There was a negative association between age and maternal mortality. The odds of maternal death decreased with increasing age by 6%. Increasing parity had a negative association with death (decreasing odds of maternal death). Domestic violence was significantly associated with maternal mortality where the odds of maternal death increased with increasing domestic violence (by 15%). Among the ethnic groups of the South, there was a significantly increased odds of maternal death (OR 1.55, 95% CI: 1.11 – 2.16) among women of the Beti/Bassa/Mbam/Kako/Meka/Pygmé ethnic group compared to the Bantoide southwest/grassfields. Compared to women living in urban areas, women living in rural areas had a 30% increase in odds of maternal mortality. Community education, community wealth, social autonomy, distance to facility, media exposure, contraception type, education, religion, wealth, and water quality were not associated with maternal mortality.

Table 5: Bivariate Analyses of Determinants of Maternal Mortality - Overall, CDHS 2004 and 2011, North and South

Variable	Overall (n=18,665) OR (95% CI)	2004 (n=7,594) OR (95% CI)	2011 (n=11,071) OR (95% CI)	North pooled (n=5,610) OR (95% CI)	South pooled (n=13,055) OR (95% CI)
Community level					
Community education	0.46** (0.30 – 0.70)	1.14 (0.54 – 2.37)	0.28** (0.16 – 0.47)	0.02* (0.001 – 0.47)	0.99 (0.47 – 2.09)
Community wealth	0.49** (0.33 – 0.73)	1.06 (0.56 – 2.02)	0.30** (0.18 – 0.50)	0.10* (0.02 – 0.64)	0.74 (0.45 – 1.24)
Individual level					
Age	0.93** (0.91 – 0.94)	0.93** (0.91 – 0.96)	0.92** (0.91 – 0.94)	0.92** (0.89 – 0.94)	0.94** (0.92 – 0.95)
Parity	0.73** (0.68 – 0.78)	0.73** (0.66 – 0.82)	0.72** (0.66 – 0.80)	0.69** (0.63 – 0.77)	0.73** (0.65 – 0.81)
Social autonomy	0.95 (0.89 – 1.03)	1.04 (0.95 – 1.14)	0.89 (0.80 – 1.00)	1.02 (0.93 – 1.12)	0.96 (0.87 – 1.07)
Domestic violence	1.06 (0.99 – 1.14)	0.98 (0.88 – 1.10)	1.13* (1.04 – 1.24)	0.95 (0.86 – 1.05)	1.15* (1.05 – 1.26)
Distance to facility					
No problem	1	1	--	1	1
small problem	0.97 (0.71 – 1.33)	--	1	1.49 (0.86 – 2.60)	0.80 (0.54 – 1.18)
Big problem	1.29 (0.98 – 1.70)	1.10 (0.80 – 1.70)	1.63** (1.15 – 2.31)	1.88* (1.16 – 3.05)	1.01 (0.72 – 1.41)
Unknown	1.40* (1.07 – 1.84)	--	1.45** (1.09 – 1.93)	2.44** (1.51 – 3.93)	1.02 (0.73 – 1.41)
Media exposure					
No exposure	1	1	1	1	1
Low exposure	0.76* (0.61 – 0.95)	0.99 (0.66 – 1.49)	0.66** (0.50 – 0.86)	0.83 (0.59 – 1.15)	0.80 (0.54 – 1.18)
Medium exposure	0.72* (0.56 – 0.93)	1.00 (0.64 – 1.57)	0.59** (0.43 – 0.81)	0.53 (0.28 – 1.00)	1.01 (0.73 – 1.53)
High exposure	0.65* (0.44 – 0.95)	1.04 (0.59 – 1.85)	0.46** (0.28 – 0.78)	0.64 (0.19 – 2.10)	1.02 (0.58 – 1.48)
Contraception type					
No method	1	1	1	1	1
Folk/traditional	0.81 (0.59 – 1.10)	1.12 (0.74 – 1.71)	0.61* (0.38 – 0.98)	1.56 (0.48 – 5.12)	0.94 (0.67 – 1.30)
Modern	0.79 (0.59 – 1.05)	0.85 (0.51 – 1.41)	0.76 (0.54 – 1.06)	0.71 (0.30 – 1.66)	0.95 (0.69 – 1.31)
Education					
No education	1	1	1	1	1
Primary	0.68* (0.54 – 0.85)	0.79 (0.55 – 1.14)	0.62** (0.46 – 0.83)	0.63* (0.43 – 0.92)	1.08 (0.63 – 1.87)
Secondary/higher	0.53* (0.42 – 0.68)	0.69 (0.46 – 1.04)	0.45** (0.33 – 0.61)	0.55 (0.26 – 1.15)	0.84 (0.49 – 1.45)
Religion					
Catholics	1	1	1	1.00	1
Other Christians	0.99 (0.77 – 1.25)	0.85 (0.56 – 1.26)	1.08 (0.80 – 1.45)	0.74 (0.45 – 1.21)	1.07 (0.82 – 1.41)
Muslims	1.10 (0.86 – 1.41)	0.82 (0.52 – 1.28)	1.26 (0.93 – 1.71)	0.69 (0.47 – 1.02)	1.03 (0.66 – 1.60)
Animist/None/Other	1.05 (0.73 – 1.51)	0.92 (0.51 – 1.63)	1.19 (0.76 – 1.88)	0.80 (0.47 – 1.36)	0.71 (0.39 – 1.29)
Ethnicity					
arab-choa/peulh/haoussa/kanuri	1	1	1	1	--
biu-mandara	1.17 (0.83 – 1.64)	1.01 (0.57 – 1.79)	1.23 (0.81 – 1.85)	1.17 (0.82 – 1.66)	--
adamaoua-oubangui	1.14 (0.80 – 1.64)	0.92 (0.50 – 1.72)	1.30 (0.83 – 2.02)	1.23 (0.83 – 1.80)	--
bantoïde south-west/grassfields	0.65* (0.45 – 0.95)	0.73* (0.37 – 1.44)	0.62* (0.40 – 0.98)	--	1
bamilike/bamoun/côtier/ngoe/oroko	0.56* (0.39 – 0.80)	0.58 (0.31 – 1.08)	0.56* (0.35 – 0.88)	--	0.89 (0.61 – 1.28)
beti/bassa/mbam/kako/meke/pygmé	0.98 (0.71 – 1.36)	1.31 (0.76 – 2.26)	0.82 (0.54 – 1.25)	--	1.55* (1.11 – 2.16)
stranger/other	1.05 (0.62 – 1.80)	1.32 (0.57 – 3.04)	0.93 (0.45 – 1.90)	0.99 (0.53 – 1.89)	1.33 (0.82 – 2.17)

Variable	Overall (n=18,665) OR (95% CI)	2004 (n=7,594) OR (95% CI)	2011 (n=11,071) OR (95% CI)	North pooled (n=5,610) OR (95% CI)	South pooled (n=13,055) OR (95% CI)
Type of residence					
Urban	1	1	1	1	1
rural	1.42** (1.17 – 1.73)	1.16 (0.83– 1.62)	1.60** (1.26– 2.03)	1.26 (0.93 – 1.71)	1.30* (1.01 – 1.67)
Wealth index					
Poor	1	1	1	1	1
Middle	0.81 (0.63 – 1.04)	0.88 (0.58 – 1.35)	0.77 (0.56 – 1.05)	0.72 (0.46 – 1.15)	1.06 (0.75 – 1.49)
Rich	0.61** (0.49 – 0.77)	0.87 (0.60 – 1.27)	0.50** (0.37 – 0.66)	0.59 (0.34 – 1.01)	0.80 (0.59 – 1.10)
Water quality					
Improved	1	1	1	1	1.00
Unimproved	1.27* (1.04 – 1.57)	1.15 (0.82 – 1.60)	1.46** (1.12– 1.92)	1.21 (0.86 – 1.69)	1.11 (0.85 – 1.45)
Region					
North	1	1	1	--	--
South	0.65** (0.54 – 0.79)	0.98 (0.69 – 1.38)	0.53** (0.42 – 0.67)		

* $p < 0.05$, ** $p < 0.01$

Distance: There were no participants with “unknown” in CDHS 2004

Ethnicity: The analyses involved two ethnicity variables to capture the different ethnic compositions of the North and South

4.4 Multivariable analyses:

To identify significant relationships between the dependent variable, maternal mortality, and the independent variables, separate multiple logistic regression models were used to assess these relationships for the pooled sample (overall), for each CDHS year 2004 and 2011, and for the North (pooled) and South (pooled) regions.

See Table 6 for complete results for questions 2, 3, and 4.

Question 2: What determinants influence maternal mortality in Cameroon?

Community wealth was significantly associated with maternal mortality in Cameroon where increasing wealth significantly reduced the odds (OR 0.31, 95% CI: 0.11 – 0.86) of maternal mortality. Increasing age and parity were both significantly associated with maternal mortality. The odds of maternal death decreased with age (OR 0.97, 95% CI: 0.96 – 0.99) and parity (OR 0.73, 95% CI: 0.67 – 0.80). Social autonomy was also significantly associated with maternal mortality. A unit increase in social autonomy of a woman increased her odds for maternal mortality by 11%. Women who had primary (OR 0.52, CI: 0.38 – 0.70) or secondary/higher education (OR 0.30, 95% CI: 0.21 – 0.44) had a significantly reduced odds of maternal mortality compared to women without any education. Community education, domestic violence, distance to facility, media exposure, contraception type, religion, ethnicity, type of residence, wealth index, and water quality were not significantly associated with maternal mortality.

Question 3: Did determinants of maternal mortality in Cameroon change between 2004 and 2011 in Cameroon?

Age, parity and education were significantly associated with maternal mortality in both CDHS 2004 and 2011. The odds of maternal mortality decreased by 3% with increasing age in both survey years. Increased parity decreased the odds of maternal death by 25% in 2004 and by 28% in 2011. Women who had primary or secondary/higher education had a significantly reduced odds of maternal mortality compared to women without any education in both 2004 and 2011. Social autonomy was significantly associated with maternal mortality only in 2004. An increase in a woman's social autonomy increased her odds for maternal mortality by 19%. This relationship was not observed in 2011. Likewise, distance to facility and community wealth were only associated with maternal mortality in 2011. Women with a big problem with distance to

facility had 46% greater odds of maternal mortality compared to women with a small problem. Community wealth, on the other hand, was negatively associated with maternal mortality. An increase in community wealth reduced the odds (OR 0.20, 95% CI: 0.05 – 0.71) of maternal death.

For both CDHS 2004 and 2011, community education, domestic violence, media exposure, contraception type, religion, ethnicity, type of resident, wealth index and water quality were insignificant.

Question 4: Do the women of the North and South regions differ on the determinants of maternal mortality?

Increasing parity and education were significantly associated with maternal mortality in the North and South. The odds of maternal death reduced by 29% and 25% with parity in the North and South respectively. In the North, women who had primary (OR 0.42, 95% CI: 0.28 – 0.62) or secondary/higher education (OR 0.26, 95% CI: 0.10 – 0.68) had a significantly reduced odds of maternal mortality compared to women without any education. In the South, women with a secondary/higher education had a 51% reduction in the odds of maternal mortality compared to women without any education.

Distance to health facility was only associated with maternal mortality in the North. Compared to women with no problem with distance to facility, those with a big problem (OR 1.94, 95% CI: 1.13 – 3.32) had a significantly increased odds of maternal mortality. Conversely, age, domestic violence and ethnicity were only significantly associated with maternal mortality in the South. The odds of maternal death decreased by 3% with age. An increase in the score for domestic violence significantly increased the odds of maternal mortality by 15%. The odds of maternal mortality almost doubled for women of the Beti/Bassa/Mbam/Kako/ Meka/Pygmé ethnic group (OR 1.80, 95% CI: 1.16– 2.80) in the South compared to those of the Bantoide South-west/grassfields ethnic group.

There was no association between social autonomy, media exposure, contraception type, religion type of residence, wealth index, water quality and maternal mortality in the North or South. Community wealth and community education were not significantly associated with maternal mortality in South.

Table 6: Multivariable Analyses of Determinants of Maternal Mortality - Overall, CDHS 2004 and 2011, North and South

Variable	Overall (n=18,665) OR (95% CI)	2004 (n=7,594) OR (95% CI)	2011 (n=11,071) OR (95% CI)	North (n=5,610) OR (95% CI)	South (n=13,055) OR (95% CI)
Community level					
Community education	3.60 (0.85 – 15.10)	5.13 (0.47 – 56.6)	3.27 (0.60 – 17.68)	--	2.54 (0.43 – 15.11)
Community wealth	0.31* (0.11 – 0.86)	0.54 (0.10 – 2.89)	0.20* (0.05 – 0.71)	--	0.45 (0.14 – 1.39)
Individual					
Age	0.97** (0.96 – 0.99)	0.97* (0.94 – 0.99)	0.97** (0.95 – 0.99)	0.97 (0.95 – 1.00)	0.97* (0.95 – 0.99)
Parity	0.73** (0.67 – 0.80)	0.75** (0.66 – 0.86)	0.72** (0.64 – 0.81)	0.71** (0.64 – 0.79)	0.75** (0.64 – 0.86)
Social autonomy	1.11** (1.03 – 1.19)	1.19** (1.05 – 1.33)	1.05 (0.96 – 1.15)	1.10 (0.98 – 1.23)	1.12 (0.99 – 1.26)
Domestic violence	1.04 (0.97 – 1.12)	0.98 (0.87 – 1.12)	1.09 (1.00 – 1.20)	0.95 (0.85 – 1.06)	1.15* (1.04 – 1.26)
Distance to facility					
No problem	1	1	--	1	1
Small problem	1.01 (0.72 – 1.41)	--	1	1.76 (0.96 – 3.25)	0.84 (0.56 – 1.25)
Big problem	1.15 (0.86 – 1.53)	0.98 (0.70 – 1.39)	1.46* (1.02 – 2.10)	1.94* (1.13 – 3.32)	0.94 (0.66 – 1.33)
Unknown	1.44** (1.08 – 1.93)	--	1.43* (1.07 – 1.93)	2.73** (1.61 – 4.65)	1.09 (0.77 – 1.55)
Media exposure					
No exposure	1	1	1	1	1
Low exposure	0.91 (0.72 – 1.15)	1.00 (0.67 – 1.51)	0.91 (0.68 – 1.21)	0.94 (0.67 – 1.31)	0.94 (0.67 – 1.33)
Medium exposure	0.99 (0.72 – 1.36)	1.04 (0.61 – 1.75)	0.98 (0.65 – 1.46)	0.61 (0.28 – 1.33)	1.14 (0.76 – 1.71)
High exposure	0.94 (0.58 – 1.53)	0.86 (0.41 – 1.81)	0.96 (0.50 – 1.83)	1.15 (0.31 – 4.19)	0.99 (0.57 – 1.73)
Contraception type					
No method	1	1	1	1	1
Folk/traditional	1.25 (0.90 – 1.74)	1.37 (0.86 – 2.19)	1.15 (0.70 – 1.89)	2.15 (0.66 – 6.98)	1.16 (0.82 – 1.65)
Modern	1.07 (0.78 – 1.48)	0.86 (0.49 – 1.53)	1.17 (0.79 – 1.73)	1.18 (0.45 – 3.10)	1.04 (0.74 – 1.47)
Education					
No education	1	1	1	1	1
Primary	0.52** (0.38 – 0.70)	0.46** (0.28 – 0.75)	0.51** (0.35 – 0.74)	0.42** (0.28 – 0.62)	0.82 (0.43 – 1.57)
Secondary/higher	0.30** (0.21 – 0.44)	0.27** (0.14 – 0.50)	0.31** (0.19 – 0.49)	0.26** (0.10 – 0.68)	0.49* (0.25 – 0.95)
Religion					
Catholics	1	1	1	1	1
Other Christians	0.99 (0.76 – 1.28)	0.86 (0.54 – 1.37)	1.06 (0.78 – 1.44)	0.72 (0.43 – 1.20)	1.10 (0.81 – 1.48)
Muslims	0.80 (0.57 – 1.13)	0.75 (0.38 – 1.48)	0.76 (0.51 – 1.13)	0.65 (0.48 – 1.02)	0.97 (0.56 – 1.68)
Animist/None/Other	0.84 (0.54 – 1.29)	0.98 (0.46 – 2.07)	0.80 (0.49 – 1.31)	0.68 (0.37 – 1.24)	0.89 (0.48 – 1.68)
Ethnicity					
arab-choa/peulh/haoussa/kanuri	1	1	1	1	--
biu-mandara	1.02 (0.69 – 1.50)	0.83 (0.38 – 1.83)	1.04 (0.65 – 1.67)	0.99 (0.66 – 1.50)	--
adamaoua-oubangui	1.14 (0.76 – 1.71)	0.81 (0.37 – 1.80)	1.36 (0.82 – 2.24)	1.19 (0.75 – 1.86)	--
bantoïde south-west/grassfields	0.67 (0.40 – 1.12)	0.56 (0.21 – 1.50)	0.76 (0.41 – 1.43)	--	1
bamilike/bamoun/côtier/ngoe/oroko	0.82 (0.48 – 1.41)	0.54 (0.20 – 1.44)	1.07 (0.56 – 2.06)	--	1.21 (0.78 – 1.88)
beti/bassa/mbam/kako/meke/pygmé	1.14 (0.64 – 2.01)	1.02 (0.36 – 2.90)	1.19 (0.60 – 2.35)	--	1.80* (1.16 – 2.80)
stranger/other	1.08 (0.62 – 1.90)	1.18 (0.48 – 2.91)	0.94 (0.45 – 1.96)	0.99 (0.49 – 1.99)	1.64 (0.94 – 2.88)

Variable	Overall (n=18,665) OR (95% CI)	2004 (n=7,594) OR (95% CI)	2011 (n=11,071) OR (95% CI)	North (n=5,610) OR (95% CI)	South (n=13,055) OR (95% CI)
Type of residence					
Urban	1	1	1	1	1
rural	1.03 (0.78 – 1.38)	1.19 (0.77 – 1.85)	0.88 (0.59 – 1.33)	0.73 (0.39 – 1.35)	1.20 (0.85 – 1.70)
Wealth index					
Poor	1	1	1	1	1
Middle	1.05(0.78 – 1.43)	1.03 (0.62 – 1.69)	1.03 (0.68 – 1.58)	0.84 (0.40 – 1.75)	1.13 (0.80 – 1.59)
Rich	0.91 (0.60 – 1.40)	1.06 (0.58 – 1.96)	0.83 (0.46 – 1.51)	0.80 (0.31 – 2.06)	0.94 (0.59 – 1.49)
Water quality					
Improved	1	1	1	1	1
Unimproved	1.01 (0.79 – 1.29)	1.00 (0.65 – 1.54)	1.11 (0.82 – 1.49)	1.15 (0.79 – 1.68)	0.89 (0.65 – 1.23)

**p<0.05, **p<0.01*

Survey adjusted

-- Notes

Distance: Unknown omitted, no observation

Community level: variables not explored in the North because the North had only three regions.

Ethnicity: Two variables for ethnic composition in the North and South

Chapter 5: Discussion

5 Discussion overview

The purpose of this study was to examine maternal mortality in Cameroon. Specifically, this study sought to estimate maternal mortality rates and ratios, to identify determinants of maternal mortality in Cameroon, and to assess differences in these determinants between the North and South of Cameroon and between 2004 and 2011. There were significant findings in Cameroon, in the North and South, and between years 2004 and 2011. These findings are the focus of this chapter where they are compared to the existing literature. The strengths and limitations of the study are also discussed with possible strategies and recommendations for future research.

5.1 Summary of findings

This study demonstrated significant associations between some independent variables and maternal mortality in Cameroon. See Table 7 below.

Table 7: Summary Table of Significant Associations Between Independent Variables and Maternal Mortality

Variable	Overall	2004	2011	North	South
Community education				n/a	
Community wealth	-		-	n/a	
Age	-	-	-		-
Parity	-	-	-	-	-
Social autonomy	+	+			
Domestic violence					+
Distance			+	+	
Media exposure					
Contraception type					
Education	-	-	-	-	-
Religion					
Ethnicity					+
Type of residence					
Wealth index					
Water quality					

(Blank cell) no significance, (-) negative association, (+) positive association, (na) not applicable

Question 1: What are the maternal mortality rates and ratios for the North and South of Cameroon in 2004 and 2011?

The assessment of maternal mortality levels in the North and South of Cameroon revealed differences in terms of their maternal mortality rates and ratios. Looking at the maternal mortality rates/ratios obtained, these differences were most visible in 2011. Maternal deaths increased in the North while they slightly decreased in the South over time.

Question 2: What determinants influence maternal mortality in Cameroon?

This study demonstrates that on the national level, there were significant associations between community wealth, women's age, parity, level of social autonomy, level of education, and maternal mortality.

Question 3: Did determinants of maternal mortality in Cameroon change between 2004 and 2011 in Cameroon?

Age, parity, and education remained consistently significant in 2004 and 2011. The exceptions were social autonomy, distance to facility and community wealth. Social autonomy was only significantly associated with maternal mortality in 2004. Likewise, distance to health facility was only significant in 2011. Community wealth was the only community level determinant of maternal mortality that was significantly associated with maternal mortality and this was only in 2011.

Question 4: Do the women of the North and South regions differ on the determinants of maternal mortality?

Central to this study was the assessment of determinants of maternal mortality in the North and South of Cameroon. The main finding is that the North and South of Cameroon are different in terms of their determinants of maternal mortality. There were distinct determinants of maternal mortality seen in the North and South. Specifically, distance to health facility was associated with maternal mortality in the North while in the South, domestic violence and ethnicity were significantly associated with maternal mortality.

Maternal mortality was significantly associated with parity and education in both the North and South as they were at the national level. However, the association between age and maternal mortality did not attain statistical significance in the North in the multivariable analyses.

All other determinants of maternal mortality (community education, media exposure, contraception type, religion, type of residence, wealth index, and water quality) which were assessed and were significantly associated with maternal mortality at either the national (pooled) level, in CDHS 2004 or 2011, or in the North or South in the bivariate level of analyses, were not found to be significant in the multivariable level of analyses.

5.2 Interpretation of findings

5.2.1 Maternal mortality rates and ratios of the North and South

The varying estimates for maternal mortality in Cameroon derived by different international agencies all place Cameroon among countries with a high maternal mortality in Sub-Saharan Africa. In fact, Cameroon's maternal mortality (782/100,000, and 669/100,000 live births for the years 2011 and 2004 respectively) is higher than that for Sub-Saharan Africa (550/100,000 live births) (Filippi et al., 2016). Though maternal mortality slightly declined in Sub-Saharan Africa, it did not do so in Cameroon (Kassebaum et al., 2014; Lawson & Keirse, 2013).

Given Cameroon's diversity, it was assumed that the maternal mortality rates and ratios for the two most distinct regions of the country (North and South) would be different. However, these rates and ratios were unknown. Hence, one study objective was to estimate the maternal mortality rate and maternal mortality ratio of the North and South of Cameroon for 2004 and 2011. The findings show differences, particularly in 2011, in maternal mortality rates and ratios between the North and South. In 2004, maternal mortality rates (per 1000 women of reproductive age) were 1.29/1000 in the North and 1.27/1000 in the South. These rates changed to 2.26/1000 for the North and 1.15/1000 for the South in 2011. This change was more noticeable in the North where the maternal mortality rate increased compared to the South where it slightly decreased. Likewise, maternal mortality ratios obtained for these two regions (North and South) in 2004 and 2011 show that maternal deaths almost doubled in the North in 2011 compared to in 2004.

This increase in the North compared to the slight decline in the South may partly explain the rising national ratio of maternal mortality in Cameroon. The sharp increase in maternal mortality

in the North may be explained by the worsening poverty of residents in the North. The Cameroon Household Surveys revealed a continuous increase in poverty in the North from 2001 to 2007 and again in 2014 (The World Bank, 2016). The large proportions of rural residents (over 70%), and poor women (about 66%) in this study are consistent with reports of the North having some of the poorest people in Cameroon (Nguetse Tegoum, 2009). These may also reflect the 12% increase in poverty between 2007 and 2014 in the region which may have impacted access to health care for these women.

Also, the influx of large numbers of displaced persons between 2004 and 2011 in Cameroon (Tatah, Delbiso, Rodriguez-Llanes, Cuesta, & Guha-Sapir, 2016) from conflict regions in countries like Chad, Nigeria, and Central African Republic (among which are women who tend to be the most affected of displaced persons) may have contributed to the high mortality in the North. Such women are especially vulnerable to poor health outcomes from a lack of resources. This places an additional strain on the already limited resources in the North. In contrast, the slight decline in the maternal mortality ratio seen in the South may suggest some degree of success from interventions to curb maternal deaths. However, the change was small.

Maternal mortality rates and ratios are indicators of maternal and women's health status but they do not reveal the specific determinants of maternal death that contribute to them. Therefore, a second objective for this study was to assess the determinants of maternal mortality in the North and South of Cameroon to see if these two regions differed through specific research questions about the determinants of maternal mortality at the national level (Cameroon), the regional level (the North and South), and over time (survey years 2004 and 2011). It was important to assess these determinants on the national level and over time so as to distinguish those that were significant at the national level and those that were unique to the North and South.

5.2.2 Determinants that influence maternal mortality in Cameroon

Age, parity and education

Age, parity and education are among the most cited reproductive and socioeconomic factors for high risk in relation to maternal health outcomes. These were important findings for the whole of Cameroon for the North and South regions.

In this study, age was significantly associated with maternal death at the national level, over time (2004 and 2011), and in the South. The odds of maternal death were low in older women compared to younger women, decreasing with increasing age. Interestingly, the impact of age on maternal death varies across several studies. The finding on age in this study, where risk was greatest among young women and lowest in older women, is consistent with some studies (Illah et al., 2013). However, other studies show risk of maternal death is greatest in the oldest age group compared to the younger age group (Chowdhury et al., 2007; Karlsen et al., 2011; Kassebaum et al., 2014), while others fail to show any association (Hoj et al., 2002). This study showed a lower risk in older women. Factors such as early marriage in Cameroon (young girls can legally marry at age 15 years) and early childbearing, increases the proportion of adolescent pregnancies which have been established as high risk for maternal mortality (Raj & Boehmer, 2013). Age was not significant in the North.

Illah et al. (2013), reported a protective effect of ever been married compared to never been married on maternal mortality after adjusting for maternal age. This means that the risk of maternal death could be even higher for women who are young and never been married. This however, could not be explored in this study because marital status was not reported for deceased siblings. It however, supports the findings of this study that the odds of maternal death are highest for younger women rather than older women.

Parity and education, on the other hand, remained significantly associated with maternal mortality across all the adjusted models for the pooled sample, in both years (2004 and 2011), and for the North and South. With regards to parity, the odds of death decreased with increasing parity. This means that maternal mortality was highest for women with the lowest number of births compared to women with more births. The higher risk of physiological complications in women with no previous births may explain why the odds of maternal death increased for low parity. This finding is in line with studies in Bangladesh and Cameroon that found that nulliparity increased the risk of maternal mortality (Chowdhury et al., 2007; Mbassi et al., 2011; Pierre-Marie et al., 2015). The cultural preference of multiple children explains the high fertility rate in Cameroon however, this study showed the risk of maternal death to be greatest among primiparous women and lowest in multiparous women.

Having had some education was associated with reduced odds of maternal mortality in the North and South, and it was also seen in the national level (pooled), and in both 2004 and 2011. This finding was consistent with the literature where women with limited or no education were more at risk of maternal death compared to educated women (Karlsen et al., 2011). Having any education (primary, secondary or higher) was protective in the North whereas only women with a secondary or higher education had a significantly lower odds of maternal mortality in the South. This may imply that a primary education alone in the South (where almost 50% of women have a secondary or higher education) does not make a significant difference in a woman's odds for maternal mortality because the South is more developed with many more women having higher education, compared to the North where a high proportion of women (over 60%) have no education.

Lower education may impact employment and maternal health services utilization and outcomes (Aremu et al., 2011). This may lead to low socioeconomic status and limited resources to seek healthcare which increases the risk of maternal mortality. This is pertinent in Cameroon where the cost of health care is mostly borne by individuals. About 50% of maternal deaths recorded in health centers in Cameroon were among women with minimal income (Mbassi et al., 2011). The low rates of higher education in the North may explain the higher maternal mortality seen in the region. Also, the influence of traditional and cultural factors, especially on maternal health seeking behavior may be especially strong. Studies have shown the influence of these factors in relation to maternal education (Karlsen et al., 2011; Thaddeus & Maine, 1994). Even though primary education was decreed free in 2000/2001 in Cameroon (Pemunta & Fubah, 2015), the high proportion of women with no education, most evident in the North, may be an indication of the deep rooted nature of traditional and cultural values.

5.2.3 Determinants of maternal mortality that changed between 2004 and 2011

Community wealth

Community health may influence the availability and access to maternal health services and positively influence maternal health outcomes (Stephenson & Elfstrom, 2012). Community wealth was only significant in 2011 compared to 2004 which may reflect the economic growth in Cameroon. However, steady economic growth is evident mostly in the South whereas the North

has seen a rise in poverty (The World Bank, 2016). The influence of community wealth was not seen in the analyses for the North and South due primarily to the small number of communities for each region.

5.2.4 Differences of determinants of maternal mortality in the North and South

North: Distance to health facility

Difficulty with distance to health facility was uniquely associated with maternal mortality in the North compared to the South. In the North, it was found that women who reported a big problem with getting to health facility had an increased odds of maternal death compared to women who had no problem with getting to health facility. Though difficulty with distance to health facility was significant, it needs further exploration because this it does not capture the actual distance. This finding of higher odds of maternal death with difficulty getting to health facility is consistent with other studies that showed an increased risk of maternal death with distance to facility (Amzat, 2015; Egbe et al., 2016; Hoj et al., 2002). The problem of distance to health facility in the North could be because of the high proportion of women (about 70%) who reside in rural areas. With hospitals and health centers mostly in urban areas, accessing the sparse health centers in rural areas would pose a major challenge for women in the North.

The impact of distance is often influenced by the lack of transportation. Distance to health facility and lack of transportation were the most frequent reasons given by women in Tanzania for not delivering at a health facility (Choe et al., 2016). This may be the situation in the North where over 60% of women were in the poor tertile and may have been without a means of transportation. Also, this finding of difficulty with accessing health facility could be capturing a problem of accessing the health facility of choice and not necessarily the nearest facility to women's home. The severe shortage of health workers in the North (Tandi et al., 2015) may mean numerous understaffed health facilities (plagued with longer wait times for health services). For instance, some health staff have reported difficulty getting to some hospitals which are located in remote, and landlocked areas in the North (Pemunta & Fubah, 2015). This may cause women to delay seeking care, opt for alternative (traditional) healthcare, or not seek healthcare at all; increasing their odds of maternal mortality.

South: Domestic violence and ethnicity

Like the North, there were determinants of maternal mortality that were significant exclusively to the South. These were domestic violence and ethnicity.

Domestic violence was significantly associated with maternal mortality in the South where the odds of maternal death increased with increasing domestic violence. This is in line with findings from other studies (Devries, Mak, García-Moreno, et al., 2013; Jewkes et al., 2010; Stöckl et al., 2013). Domestic violence is widespread in Cameroon with about 51% of ever-married women reporting having experienced physical or sexual violence by a husband or partner. Specifically, sexual violence was found to be common in the South among host and refugee population in Cameroon (Parmar, Agrawal, Greenough, Goyal, & Kayden, 2012). A chi square test of domestic violence and region (North and South) in this study, confirmed that the distribution of domestic violence is statistically different between the North and South. The south had more women who agreed that domestic violence was justified.

One way domestic violence may be contributing to maternal mortality is through illegal abortions. Intimate partner violence was found to increase the risk of induced abortions in Cameroon (Alio et al., 2011). Meanwhile, abortions are illegal in Cameroon. Women may resort to the use of illicit abortion services that increase the risk of maternal mortality and thereby, contribute to the 9.6% of maternal deaths in sub-Saharan Africa linked to abortions (Say et al., 2014). With abortions already under-reported in Cameroon and domestic violence affecting all classes of women in the country, the scope of maternal complications and deaths that may arise from induced abortions are most likely underestimated.

Also, domestic violence may be significant in the South because of a culture in which the acceptance of domestic violence is deep-seated. The acceptability of domestic violence makes it hard for victims to be identified and helped just as women who experience domestic violence may not know that it is unacceptable behavior. Domestic violence persists in part due to societal norms that condone intimate partner violence and viewed it as a private issue between partners in Cameroon. The significant influence of domestic violence on maternal mortality in the South may indicate that domestic violence is more prevalent than the North.

Also, the excessive consumption of alcohol in Cameroon (Kongnyuy & Wiysonge, 2007), which can impact the frequency and severity of violence against women by their partners, may explain why domestic violence was significantly associated in the South where alcohol consumption has

been found to be particularly high (Kengne, Awah, Fezeu, & Mbanya, 2007). Extramarital relations, which increases the risk of HIV infections for partners, has been linked with alcohol consumption in Cameroon (Kongnyuy & Wiysonge, 2007). This means that vulnerable women may not only be at risk of physical and mental injury from domestic violence, but may also be at risk of HIV. These findings stress the need for an effective strategy to reduce the prevalence of domestic violence in Cameroon.

In the south, ethnicity was significantly associated with maternal mortality. The odds of maternal mortality were significantly higher for Beti/Bassa/Mbam/Kako/Meka/Pygmé women compared to Bantoide/Grassfields women. This finding is consistent with other studies that show a significant association between ethnicity and maternal mortality in other African countries (Evjen-Olsen et al., 2008; Nair et al., 2015; Rogo et al., 2006; Ujah et al., 2005). Several factors could influence the outcome of maternal mortality within ethnic groups. In Cameroon, each ethnic group has its own unique set of practices that impact maternal health. In the case of the women from the Beti/Bassa/Mbam/Kako/Meka/Pygmé ethnic group, cultural practices could be the determining factor. For instance, it was reported that sugar cane peel is used for cutting the umbilical cord during delivery by women of the Baya ethnic group (a subgroup of Beti/Bassa/Mbam/Kako/Meka/Pygmé) (Defo, 1996). This is likely to increase the odds of infection for both mother and infant. This ethnic group was found to report higher numbers of illness compared to other ethnic groups in the country and to favors early childbearing (Defo, 1997).

Maternal nutritional status may be affected by practices within the ethnic group. A study in this ethnic group found that majority of the people blamed complications at birth to the woman's infidelity during pregnancy and preferred a traditional birth attendant to a skilled attendant during a woman's delivery (Azevedo, Prater, & Lantum, 1991). Also, the environmental condition and climate (warm to humid equatorial climate) of the regions (administrative regions of the Centre, South and East) where this group predominantly resides may favor the prevalence of certain diseases. These may adversely affect pregnant women of this ethnic group (Defo, 1996) who are a high risk group for infections, leading to an increased risk of maternal mortality.

In all, these findings show the differences in the determinants of maternal mortality in the North and South. Maternal mortality in the North is influenced by the socioeconomic conditions

(structural factors) of the region manifested in the difficulty women have in accessing health facilities while prevailing sociocultural factors, from domestic violence and ethnic factors, contribute to maternal mortality in the South.

5.2.5 Notable inconsistent findings: media exposure, contraceptives and social autonomy

Media exposure and contraceptives

Interestingly, media exposure and contraception use were not associated with maternal mortality at the regional (North and South) or national (pooled, 2002 and 2011) levels. Mass media plays a pivotal role in the delivery of health information (Choe et al., 2016; Wakefield et al., 2010) and is a primary tool for health education in Cameroon. Mass media is credited with some improvements in maternal health outcomes in LMICs through improving health behavior such as increased use of health professional for delivery care in Ghana (Mills, Williams, Adjuik, & Hodgson, 2008) and increased use of treated bed nets in Cameroon (Bowen, 2013). In this study, media exposure was only significant in the unadjusted models for the pooled and 2011 samples where higher levels of media exposure were associated with a reduction in the odds of maternal mortality. However, there was no association with maternal mortality in the adjusted models.

This may suggest that some media campaigns in Cameroon are short-lived with limited reach to the target population. For instance, a review of media campaigns in LMICs showed the limited impact media had on the uptake of contraceptives and the use of condoms (Hornik & McAnany, 2001). In Cameroon's case, the association between media and maternal mortality may be poor because the main media campaign has been about increasing the use of modern contraceptives (the main intervention adopted by Cameroon for the reduction of maternal mortality) which was also not associated with maternal mortality in any of the adjusted models in this study. Over 70% of the participants in this study were non-users which is consistent with other studies that express the low prevalence of contraceptive use in Africa (Buor & Bream, 2004; Diorio & Crivelli-Kovach, 2014).

Though some elements (cost, availability and need for spousal/parental approval) may hinder the uptake of contraceptives in women, media messages alone may not effectively influence the use of contraceptives. One successful media campaign to improve use of modern contraceptives in

Cameroon incorporated community mobilization activities (Babalola, Vondrasek, Brown, & Traore, 2001). However, many media campaigns with excellent evidence-based information, are produced without community involvement and so miss the opportunity to engage, educate and influence beliefs and attitudes that function as barriers to improve maternal health outcomes. In this study, over 60% of women had low to no media exposure. This suggests that the platforms used by traditional media campaigns may be unsuitable to reach women particularly, those in rural areas.

Social autonomy

Social autonomy was positively associated with maternal mortality in Cameroon at the national level (pooled) and in 2004. The odds of maternal mortality increased with increasing social autonomy. This finding was unexpected as it contrasts with studies that found an association between high levels of autonomy and improved maternal health outcomes (Stephenson & Elfstrom, 2012; Woldemicael, 2010). Greater autonomy improves health behavior (adoption of modern contraceptives, and the utilization of antenatal and delivery care services) (Woldemicael, 2010) and is also linked with higher socioeconomic status (being educated and employed) in women (Pambè et al., 2014), while low autonomy negatively impacts women's health (Diorio & Crivelli-Kovach, 2014).

The persistent issue of gender inequality and its varied impacts on women in the Cameroonian society likely explain this finding. Having high autonomy may expose a woman to other negative behavior from her husband or partner. Husbands/partners may still exert more control over women with high levels of social autonomy or provide minimal support (such as support with duties during pregnancy) to their wives/partners due to unquestioned traditional gender roles. Women have experienced negative behavior from husbands/partners with their transition from solely housewives duties to gainful employment (Kaye et al., 2005). Nonetheless, this study, showed that the influence of social autonomy on maternal mortality changed over time. Social autonomy was not associated with maternal mortality in 2011 or regionally.

5.3 Policy implications

5.3.1 Context

Cameroon is committed towards improving maternal health. However, several issues exist within the country which contribute to the problems faced by the health care system.

Male engagement

Lack of financial support or transportation to visit health facility, no support for family planning resources, domestic conflict, unequal gender based duties and no assistance with work load during pregnancy are just some forms of male disengagement in maternal health. Studies have shown a positive association between male engagement in maternal health and the utilization of maternal health services (Redshaw & Henderson, 2013; Tweheyo, Konde-Lule, Tumwesigye, & Sekandi, 2010) and improved maternal health outcomes in developing countries (Yargawa & Leonardi-Bee, 2015). In traditionally patriarchal societies in LMICs like Cameroon, men are often the gatekeepers of their families' resources and decision makers about their partners' health. Yet, they are far removed from the healthcare of their families. Lack of involvement by men in the healthcare of their wives/partners, particularly during pregnancy and childbirth, is sustained by the belief that these events should be managed solely by women.

Male engagement is often determined by level of education, income, and the men's personal beliefs and attitudes (Ditekemena et al., 2012). Non-engagement by men in supporting their wives/partners during pregnancy and birth may be encouraged by women themselves who view men as uninformed about pregnancy and childbirth. However, a study in Cameroon found that men were actually knowledgeable about maternal health but traditional barriers from gender roles prevented their engagement (Nkuoh et al., 2010). Some women's educational background and personal beliefs, may prevent or influence the level men's engagement in maternal health care which may be contributing to the outcome of maternal mortality in Cameroon.

Challenges due to lack of good governance

The fight against maternal mortality in LMICs like Cameroon is difficult due to inadequacies within their health systems that may explain these problems. Maternal mortality may be competing for resources with other public health issues that health policy makers deem more pressing. It is even more daunting when these challenges have to be tackled with very limited resources. For instance, community-based financial schemes such as health insurance that would significantly alleviate the burden of healthcare cost on individuals, and pregnant women in particular, are sparse in Cameroon. In 2011, about 96% of women reported having no health

insurance (Institut National de la Statistique & ICF International, 2012). Overall government spending is on health low (Institut pour la Recherche de développement et la Communication, 2012; Kingue et al., 2013). This leaves maternal health programs, like other health programs underfunded.

Corruption, lack of political will and leadership crises are the most visible drawbacks of the system of governance that may impact maternal health. There still exist structural barriers to accessing tertiary healthcare for maternal services that may influence maternal mortality. The centralized system of administration may impair local district efforts to manage health problems within healthcare. For instance, in 2009, about 30% to 40% of funds allocated for health units were never received (Campos G. et al., 2013). Also, poor remuneration of health workers, as seen in Uganda (Ackers, Ioannou, & Ackers-Johnson, 2016), is pervasive in Cameroon (Israr et al., 2000; Tandi et al., 2015). These factors impact health facilities ability to maintain stocks and health workers performance which in turn may be contributing to the burden of maternal mortality in Cameroon.

Poor quality of health services

Skilled birth attendants at delivery avert many obstetric complications that lead to maternal death. Poor service quality on the other hand, discourages use of health facilities and may explain some of the findings of this study. Some health professionals have been found to treat patients poorly (Fokunang et al., 2011) which has steered women towards alternative health services from traditional health providers. A large proportion of women in Cameroon still give birth outside the formal health system often with the assistance of traditional birth attendants, relatives or with no assistance at all. This poor service quality in the formal health system has partly encouraged the persistent popularity of traditional health providers in Cameroon.

Traditional health providers were reported to attend to their patients differently compared to providers in the formal health sector in Cameroon (Labhardt, Aboa, Manga, Bensing, & Langewitz, 2010). Consultations were more patient-centered with discussions about psychosocial issues, probing patient's opinion and discussing illness. However, there are risks of maternal mortality associated with unskilled birth attendants.

5.3.2 Recommendations

This study illustrated some important issues affecting maternal health in Cameroon and points to potential policies that the government of Cameroon can adopt to prevent and reduce maternal deaths. Based on the findings of this study, the following recommendations were made.

Tackle the levels of maternal mortality in the North

Between 2004 and 2011, maternal deaths almost doubled in the North of Cameroon. The North is plagued with a severe shortage of health care providers, a problem of distance to health facility, and a large number of displaced persons from conflict zones. Hence, the government of Cameroon needs to tackle the rising levels of maternal mortality in this region by devoting more resources to improve maternal health.

Specifically, the government needs to invest in training and increasing the number of community health workers in the North. Community health workers play a vital role in supporting the health of hard to reach populations and can be the link between pregnant women and the health care system. Also, the government should develop programs to engage community leaders in the efforts to improve the health of mothers in the North. These leaders can influence their community members' beliefs and behavior by encouraging the use of skilled birth attendants. The high proportion of poor women and displaced persons in the North means many women have limited resources to access the health care system. Therefore, cost of antenatal care at health facilities should be reviewed and reduced.

Education

This study stressed the impact of education on maternal mortality. Yet, many women in this study had no education. This emphasizes the need for the government of Cameroon to adopt new strategies to improve education and school attendance in women, particularly in the North. This may include better retention strategies of teachers and incentives to encourage the attendance of primary school. For instance, compensation for individuals who accept teaching posts in the North should be increase. There should also be on-site supervisors for schools in the North to improve staff attendance.

Health communication

The government of Cameroon needs to explore alternative strategies for health promotion and education. Mass media, known for boosting the uptake of interventions, is a major tool in Cameroon for health communications. However, about a third of the study population had no media exposure, suggesting that many in the target population are not being reached by media messages. Hence, alternate strategies (such as text messages on maternal health to cell phones and basic health education through community health workers) should be explored for health education and communication.

Also, support programs for victims of domestic violence are few. With domestic violence associated with maternal mortality, community education is needed to influence attitudes and perceptions about domestic violence. Hence, the government should create programs that sensitize the public about the harms of victims of domestic and also provide safe and private services for victims.

5.3.3 Improve data collection for maternal mortality/morbidity

The DHS data used for this study had a limitation in the breadth of information that could be obtained for the deceased siblings. There is therefore need for further information on women that died in national surveys for Cameroon such as those ascertained through verbal autopsies. Also, specific information that would be useful for future studies include data about the location where women died or lived. This may help increase the accuracy of measures on the level of maternal mortality particularly in regions within Cameroon.

5.3.4 Future research

Future large studies on maternal mortality in Cameroon would be of interest. This study found that ethnicity and domestic violence were associated with maternal mortality in the South. These are factors that are interrelated with other sociocultural factors and thus, several questions remain to be resolved; in particular what aspects of an ethnic group makes the women of that group at risk of maternal mortality. Hence, there is need for further research in the quality of health services which may inform strategies for improvements in the delivery of care in the formal health care sector.

5.4 Limitation

5.4.1 Data limitations

Some study limitations pertain to the outcome measure of maternal mortality. It is expected that the number of maternal deaths identified for this study are underreported based on the sensitive nature of some circumstances around maternal mortality which may prevent respondents from disclosing a maternal death. Hence, the estimate may not fully reflect the burden of maternal mortality in Cameroon. Being a relatively rare event, maternal mortality is often measured over longer specified periods - 7 years in the CDHS. This means that the derived estimates represent the risks of maternal mortality in Cameroon in the 7 years prior to the survey data collection and not the survey year alone. The drawback is that the estimates for maternal deaths in Cameroon may obscure annual variations in maternal mortality.

There was limited information for deceased women in the CDHS. Only data on age and parity was available which necessitated the use of select respondent characteristics for the deceased siblings to allow for comparisons on more determinants of maternal mortality. This also required the exclusion of variables such as nutritional and health status from the analyses as these could not be ascribed to deceased siblings. Some variables were equally dropped from the McCarthy and Maine framework because they were not available in the CDHS. This may have introduced some bias in this study as health status is an important determinant of maternal mortality that could not be explored in this thesis.

Also, the assumption made was that deceased siblings share the same characteristics (based on the variables selected) as the respondents. It is possible that some deceased siblings may have differed from their living siblings on one or more of the selected characteristics that were ascribed to them. Still, data provided by the siblings of deceased women contain important information and remain very useful where other data (vital registry) are limited.

5.4.2 Methodological limitations

The methods used for data collection and analyses introduced some limitations in this study. Firstly, respondents needed to recall information about their deceased siblings. Also, some key factors could not be fully explored. For instance, it was an interest of this study to explore the association of community level variables on maternal mortality at the district level. However,

community level variables could only be assessed at the regional level. With only 3 regions in the North and 9 in the South, this study could not capture the influence of community level variables at the regional level.

Two CDHS datasets were pooled to provide a larger sample size to investigate maternal mortality. However, combining the two datasets required adjustments to be made for some variables (social autonomy and distance to health facility) before they could be included for analyses because of increase in the proportions of missing responses. Also, the skip pattern employed in the CDHS of 2011 created a large proportion of women from whom no response was obtained for distance to health facility. To retain this women in this study, they were coded as unknown. This unknown status of distance to facility was significantly associated with maternal mortality but could not be looked into further or explained because this group could have consisted of women with different levels of difficulty accessing a health facility. Despite these limitations, data from the CDHS provide valuable insight into Cameroonian women's risks of maternal mortality.

Multilevel logistic regression models were considered for this study to assess the influence of the community level factors but could not be applied to the data. There was a limited number of clusters at the regional level (12 regions) and no clusters at the district level to apply these models. Hence, community level factors (community wealth and community education at the regional level) were included in the single level logistic regression analyses.

5.5 Study contributions

Reducing maternal mortality in Cameroon remains an important goal. This study is the first to examine the determinants of maternal mortality in Cameroon using national representative data and exploring differences between the two broader North and South regions. The main findings show regional differences in the levels and determinants of maternal mortality. An implication of this is the impact the adoption of regional interventions will have on the national scale. Targeting specific regional determinants of poor maternal outcomes will not only improve health conditions for women of the respective region, but also contribute towards the reduction of maternal mortality at the national level. For instance, community education about the harms of domestic violence may have social change implications that lead to the creation of more services to attend to victims of domestic violence in the South, and other regions as well.

This study can form part of the basis for efforts to improve the sparse data on maternal mortality in Cameroon. The findings are useful for current and future programs for maternal health.

Through the provision of improved information, the findings of this study can serve as baseline data to evaluate the impact of programs implemented to address the identified problems leading to maternal mortality. Also, the findings may have implications for other health indicators and subpopulations like children's health, which share similar determinants like maternal mortality. Programs to improve maternal health will in turn benefit children and families of women whose wellbeing is heavily influenced by maternal mortality.

5.6 Strengths of study

Generalization from results

While most studies on maternal mortality have focused on facility based deaths in Cameroon, this study assessed maternal deaths with population level data using an approach that allowed for the comparison of deceased siblings to living women. Also, the DHS ensures the representativeness of its surveys. The findings are thus generalizable to the North, and South regions, and to the entire country. The findings of this study suggest that this approach of using and ascribing select sibling characteristics to the deceased may also be beneficial in other regions with limited data or difficulty measuring maternal mortality.

5.7 Conclusion

This study measured levels of maternal mortality and identified its determinants within the North and South regions, and across Cameroon. The findings showed differences in maternal mortality between the North and South, and reinforced the recommendations for regionally relevant interventions. This study thereby has implications for programs aimed at improving maternal health and reducing maternal mortality. Given the unique associations of maternal mortality with distance to facility in the North, and domestic violence and Ethnicity in the South, there is need to focus interventions specifically for the North and South. Age, parity, education and women's social autonomy were determinants of maternal mortality with countrywide significance and so should be national priority for programs to reducing maternal deaths.

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Appendix 1: Western University Research ethic waiver

**Western
Research**

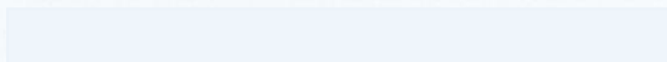
November 19, 2016

Research Ethics

Dear Ms. Ngeh Meh,

In accordance with the Tri-Council Policy Statement 2: Ethical Conduct of Research Involving Humans, Article 2.4. "REB review is not required for research that relies exclusively on secondary use of anonymous information, or anonymous human biological materials, so long as the process of data linkage or recording or dissemination of results does not generate identifiable information." Based on the information you provided in your emails on Oct 4 and Oct 11, 2016 regarding the project you are doing on the determinants of maternal mortality in Cameroon it is my opinion, the above-referenced research project falls within that description and therefore REB review is not required.

I wish you the best of luck with your work.



Appendix 2: Grouping of Ethnic Categories between surveys CDHS 2004 and 2011

Cameroon 2004			Cameroon 2011			
	Final Report					
1	Arab-Choa/Peulh/ Haoussa/Kanuri	1 to 4	1	arabe-choa	1	arab-choa/peulh/ haoussa/kauri
			2	Peulh		
			3	haoussa		
			4	kanuri		
2	Biu-Mandara	5 to 16	5	bata	2	biu-mandara
			6	daba		
			7	guidar		
			8	kotok		
			9	kwang/kera		
			10	mafa		
			11	margui		
			12	massa		
			14	mousgoum		
			15	sara		
			16	wandala/mandara		
3	Adamaoua-Oubangui	17 to 23	17	dourou	3	adamaoua-oubangui
			18	fali		
			19	gbaya		
			21	mambila		
			22	mboum		
			23	samba		
4	Bantoïde Sud-ouest	24 to 29	24	banyang	4	Bantoïde Sud-ouest
			25	bendi		
			26	efik-korop		
			27	ejagham		
			28	mbembe		
			29	tiv		
5	Grassfields	30 to 35	30	bebe	5	grassfields
			31	menchum		
			32	momo		
			33	ngemba		
			34	ring		
			35	wimbum-yamba		
6	Bamilike/Bamoun	36 to 37	36	bamoun	6	bamilike/bamoun
			37	bamilike-central		
7	Côtier/Ngoe/Oroko	38 to 39	38	cotier	7	Côtier/Ngoe/Oroko
			39	ngoe-oroko		
8	Beti/Bassa/Mbam	40 to 45	40	bafia	8	beti/bassa/mbam
			41	banen-bandem		
			42	yambassa		

			43	bassa-bakoko		
			44	beti		
			45	boulou-fang		
9	Kako/Meka/Pygmé	46 to 48	46	kako	9	kako/meke/ Pygmé
			47	meka		
			48	pygmee		
10	Étranger	96	49	African	10	stranger
			51	foreigner		
			96	other		
11	ND	99;	98	dk		

Appendix 3: Permission to reprint image of conceptual framework



Publications

10:02 AM



RE: Requesting permission to use figure from article

To: Catherine Ngeh Meh

Dear Catherine,

On behalf of the Population Council and *Studies in Family Planning*, you have our permission to use the image from the article entitled "A framework for analyzing the determinants of maternal mortality," which appeared in the Jan–Feb 1992 issue of the journal.

Please use a source citation similar to the following:

Source: McCarthy, James and Deborah Maine. 1992. "A framework for analyzing the determinants of maternal mortality," Studies in Family Planning 23(1): 23–33.

Please don't hesitate to contact us if you have any additional questions. Thank you.

Appendix 4: List of selected variables and recode options

Category	Variable	Variable Description	Response options in CDHS	Recoded variables
Maternal mortality	MM6	Years since sibling died	0:96 (range: 0 to 96 years) 97 97+ (inconsistent code) 98 Don't know 99 Missing Not applicable	No recode
	MM9	Sibling death & pregnancy	0 Never pregnant 1 Death not related 2 Died while pregnant 3 Died during delivery 4 Since delivery 5 6 weeks after delivery 6 2 months after delivery 98 Don't know 99 Missing Not applicable	0 non maternal death (options 0,1, and 6) 1 maternal death (options 2,3,4, and 5)
Reproductive status (Age & Parity)	V012	Respondent's current age	15:49 Not applicable	No recode
	V013	Age in 5 year group	1 15-19 2 20-24 3 25-29 4 30-34 5 35-39 6 40-44 7 45-49	Item MM7 was used to create age category for deceased siblings and then merged with this variable
	MM7	Siblings age at death	0:96 97 97+ 98 Don't know 99 Missing Not applicable	No recode
	MM14	Number of sibling children	0:24 (m) 99 Missing Not applicable	No recode
	V201	Total children ever born	0:20	No recode
	V131	Ethnicity* <i>Ethnicity was coded differently for 2004. Appendix provides details on how final recode categories were derived</i>	1 Arab-Choja/Peulh/Haoussa/Kanuri 2 Biu-Mandara 3 Adamaoua-Oubangui 4 Bantoïde South-West 5 Grassfields 6 Bamilike/Bamoun 7 Côtier/Ngoe/Oroko 8 Beti/Bassa/Mbam 9 Kako/Meka/Pygmé 10 Stranger / other 999 Missing Not applicable	1 arab-choja/peulh/haoussa/kanuri 2 biu-mandara 3 adamaoua-oubangui 4 bantoïde south-west/grassfields 5 bamilike/bamoun/côtier/ngoe/oroko 6 beti/bassa/mbam/kako/meke/pygmé 7 stranger/other
	V130	Religion	1 Catholic 2 Protestant 3 Moslem 4 Animist 5 Other Christian 7 None	1 Catholics 2 other Christian (option 2 & 5) 3 Moslem 4 Animist/None/Other

			96 Other 99 Missing Not applicable	
Location	V024	region	1 Adamaoua 2 Centre 3 Douala 4 Est 5 Extrême-Nord 6 Littoral 7 Nord 8 Nord-Ouest 9 Ouest 10 Sud 11 Sud-Ouest 12 Yaoundé	1 North (options 1, 5, 7) 2 South (2, 3, 4, 6, 8, 9, 10, 11, 12)
	V025	Type of place of residence	1 Urban 2 Rural	No recode
SES	V106	Highest level of education	0 No education 1 Primary 2 Secondary 3 Higher 9 Missing	0 no education 1 primary 2 secondary/higher (options 2 and 3)
	V190	Wealth index	1 Poorest 2 Poorer 3 Middle 4 Richer 5 Richest Not applicable	1 poor (1, 2) 2 middle (3) 3 rich (4,5)
Healthcare behavior	V313	Current contraception method type use	0 No method 1 Folkloric method 2 Traditional method 3 Modern method 9 Missing	0 no method 1 folk/traditional 2 modern
Woman's characteristics	V744 (a, b, c, d)	Domestic violence beating justified if wife <i>-goes out w/o telling</i> <i>-neglects the children</i> <i>-argues with husband</i> <i>-refuses to have sex</i>	0 No 1 Yes 8 Don't know 9 Missing Not applicable	0 No 1 yes/don't know Then composite variable generated as a sum of responses
	V743 (a, b, c, d)	Autonomy/decision making on <i>-respondent's health</i> <i>-large h.hold purchases</i> <i>-household purchases</i> <i>-visit to family</i> (n=9743)	1 Respondent alone 2 Respondent and husband/partner 4 Husband/partner alone 5 Someone else 6 Other 9 Missing	1 yes (1, 2) 2 no (4, 5, 6) Then composite variable generated as a sum of responses

Media exposure frequency	V157	-Frequency of reading newspaper or magazine	0 Not at all 1 Less than once a week 2 At least once a week 3 Almost every day	Composite variable generated With a score range 0 - 9 and recoded as follows: 0 no exposure (score 0) 1 low exposure (1 -3) 2 medium exposure (4-6) 3 high exposure (7 - 9)
	V158	-Frequency of listening to radio	9 Missing Not applicable	
	V159	-Frequency of watching television		
Distance to facility	V467d	Getting medical help for self: distance to health facility	0 No problem 1 Big problem 2 Not a big problem 9 Missing Not applicable	0 no problem 2 small problem 3 big problem
Water quality	V113	Source of drinking water	10 PIPED WATER 11 Piped into dwelling 12 Piped to yard/plot 13 Public tap/standpipe 20 TUBE WELL WATER 21 Tube well or borehole 30 DUG WELL (OPEN/PROTECTED) 31 Protected well 32 Unprotected well 40 SURFACE WATER 41 Protected spring 42 Unprotected spring 43 River/dam/lake/ponds/stream/canal/irrigation channel 51 Rainwater 61 Tanker truck 62 Cart with small tank 71 Bottled water 96 Other 97 Not a de jure resident (m) 99 Missing	1 improved (11, 12, 13, 21,31,41, 51) 2 unimproved (32, 42, 43, 61, 62, 71, 96)

Appendix 5: Response categories for CDHS 2004 & 2011 for Source of water quality

2004	2011
10 piped water	10 piped water
11 in the house	11 piped into dwelling
12 in the courtyard	12 piped to yard/plot
13 of a neighbor	13 public tap/standpipe
14 along the road	20 tube well water
20 open well water	21 tube well or borehole
21 well with pump	30 dug well (open/protected)
22 non protected well	31 protected well
30 covered well/borehole	32 unprotected well
31 protected without pump	40 surface water
40 surface water	41 protected spring
41 river/stream not protected	42 unprotected spring
42 protected source	43 river/dam/lake/ponds/stream/canal/irrigation channel
51 rainwater	51 rainwater
96 other	61 tanker truck
97 not de jure resident	62 cart with small tank
	71 bottled water
	96 other
	97 not a de jure resident

Appendix 6 Detailed multivariable regression analyses

Detailed Multivariable analyses

One objective of this study was to determine whether the North and South of Cameroon differ in terms of determinants of maternal mortality through specific research questions. Survey adjusted multivariable logistic regression analyses were used to investigate the association between the independent variables and the outcome variable while controlling for other variables. The analysis steps are organized by research question.

Question 2: “What determinants influence maternal mortality in Cameroon?”

Multivariable logistic regression analysis was run to investigate the association between the outcome variable and the independent variables.

Outcome variable:

Y=Maternal mortality

Individual level variables:

X₁=Age, X₂=Parity, X₃=Distance to facility, X₄=Media exposure,
X₅=Contraception type, X₆=Social Autonomy, X₇=Domestic violence,
X₈=Education, X₉=Religion, X₁₀=Ethnicity, X₁₁=Type of residence,
X₁₂=Wealth index, X₁₃=Water quality

Community level variables:

X₁₄=Community wealth, X₁₅=Community education

Question 3: “Did determinants of maternal mortality change between 2004 and 2011 in Cameroon?”

To investigate if determinants change over time between 2004 and 2011, 2 separate models were run for each survey year.

Outcome variable:

Y=Maternal mortality

Individual level variables:

X₁=Age, X₂=Parity, X₃=Distance to facility, X₄=Media exposure,
X₅=Contraception type, X₆=Social autonomy, X₇=Domestic violence,
X₈=Education, X₉=Religion, X₁₀=Ethnicity, X₁₁=Type of residence,
X₁₂=Wealth index, X₁₃=Water quality.

Community level variables:

X₁₄=Community wealth, X₁₅=Community education

Question 4: “Do the women of the North and South regions differ on the determinants of maternal mortality in Cameroon?”

To assess for differences between the North and South two separate models were run for the North and for the South.

For the North, the variable North ethnicity was included.

Outcome variable:

Y=Maternal mortality

Individual level variables:

X₁=Age, X₂=Parity, X₃=Distance to facility, X₄=Media exposure,
X₅=Contraception type, X₆=Social autonomy, X₇=Domestic violence,
X₈=Education, X₉=Religion, X₁₀= North_Ethnicity, X₁₁=Type of residence,
X₁₂=Wealth index, X₁₃=Water quality.

Community level variables were not included

The second model was for the South. The variable South _Ethnicity was included.

Outcome variable:

Y=Maternal mortality

Individual level variables:

X₁=Age, X₂=Parity, X₃=Distance to facility, X₄=Media exposure,
X₅=Contraception type, X₆=Social autonomy, X₇=Domestic violence,
X₈=Education, X₉=Religion, X₁₀=South_Ethnicity, X₁₁=Type of residence,
X₁₂=Wealth index, X₁₃=Water quality.

Community level variables:

X₁₄=Community wealth, X₁₅=Community education

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Presentations:

Meh, C. N., Gill, J., Kim, D. H. (2012) Melanin: A friend or foe? A comparison of skin cancer knowledge, attitude, and protective behavior in African American students in east and west coasts. *National Institute of Health/National Institute of Minority Health & Disparities (NIH/NIMHD) 2012 Summit, National Harbor, MD. Abstract accepted.* Poster presentation on Dec 17-19, 2012

Meh, C. N., Gill, J., Kim, D. H. (2011) Melanin: A friend or foe? A comparison of skin cancer knowledge, attitude, and protective behavior in African American students in east and west coasts. *International Organization of Social Sciences and Behavioral Research (IOSSBR) Winter 2011 Conference, Las Vegas, NV. Abstract accepted.* Poster presentation on Nov 17-18, 2011